Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MARCH, 1953 TECHNOLOGY DEPT

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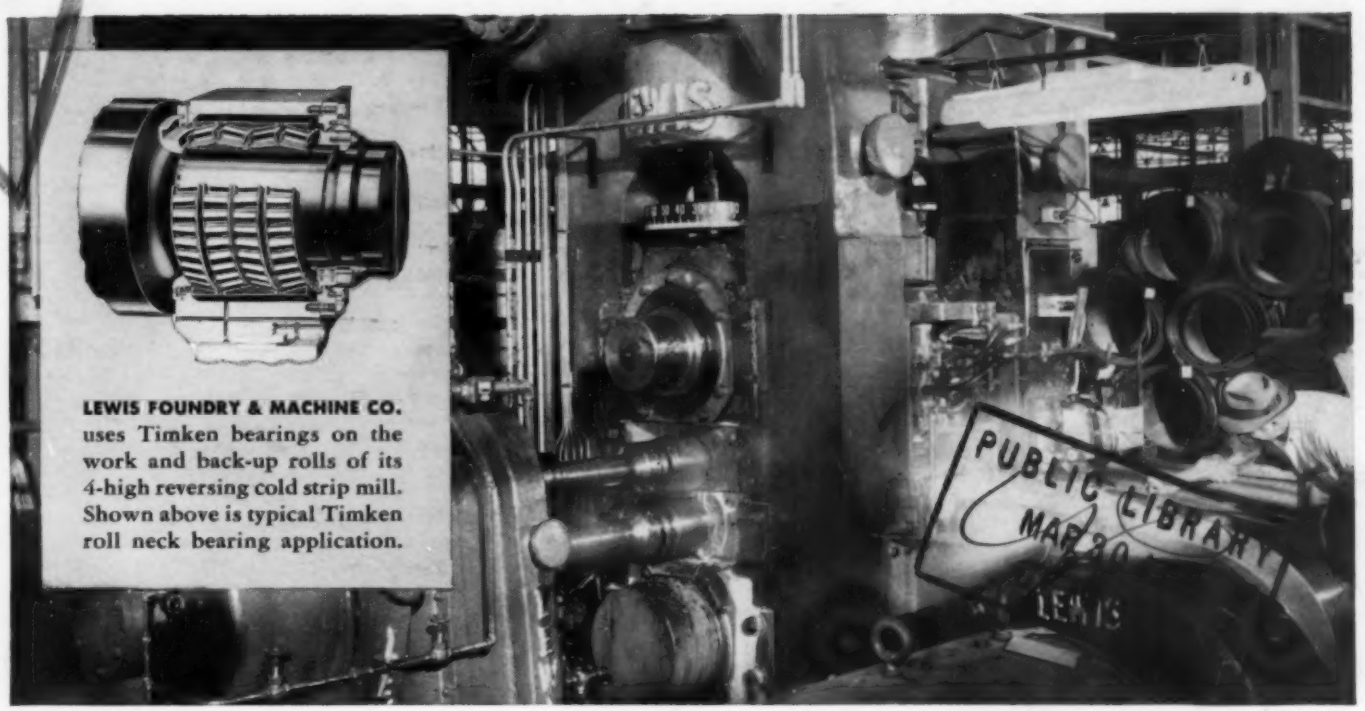


LEWIS FOUNDRY & MACHINE CO. uses Timken bearings on the work and back-up rolls of its 4-high reversing cold strip mill. Shown above is typical Timken roll neck bearing application.

7 ways TIMKEN® bearings help Lewis strip mill strip costs

TIMKEN® bearings on the work and back-up rolls of this Lewis 4-high reversing cold strip mill cut costs 7 ways:

1) Timken tapered roller bearings take both radial and thrust loads in any combination. No special thrust units are required, chuck mountings are simpler and more compact, weight is minimized.

2) Mill can be stopped and restarted without altering or relieving screw-down pressures. Scrap loss caused by loss of gauge is eliminated.

3) Timken bearings have lower starting resistance, permit the mill to accelerate more rapidly. Skidding or scuffing between work and back-up rolls is reduced.

4) The mill can be adjusted quickly under full load at low operating speeds and while reversing rolling directions.

5) Timken bearings permit use of economical grease lubrication. There's no loss of lubricant during roll changes, rolls can be changed faster. Complicated lubricating systems and large oil reservoirs are eliminated.

6) Less leakage of lubricant with Timken bearings because closures are more efficient with grease lubrication.

7) Back-up rolls can be driven easier on Timken bearings. Less hydraulic accumulator pressure is needed.

Besides the 8 Timken bearings on the work and back-up rolls, a total of 14 Timken bearings are also used on the motor screwdowns, tension reels, combination drive and pinion stand of the Lewis mill. It will pay *you* to specify Timken bearings for all your new and existing equipment. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

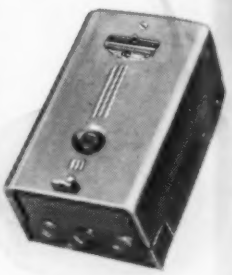
TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

Now CUTLER-HAMMER *proudly presents the spectacular new ☆☆☆ motor control*

Entirely new in concept and design. Wide-open accessibility. Remarkably improved performance. Vastly increased operating life.



This is important news for the men of industry. It marks a new day of improved electric motor performance. A new day of more accurate and more dependable motor protection. A new day of simpler, easier, faster motor control installation. This is the quick story of the spectacular new Cutler-Hammer ☆☆☆ Motor Control. But thousands of words could not tell this story in its important details.

Cutler-Hammer ☆☆☆ Motor Control can be known *only* by its performance. Field-tested for more than two years in hundreds of the most trying motor control assignments, its first users have said time and again that there has never been anything like it before. And these users were *looking* for faults. You need not be moved by their enthusiasm. But you cannot ignore their factual reports.

If you use electric motors, you *must* know the facts about Cutler-Hammer ☆☆☆ Motor Control...how much more it offers than any motor control you have ever used. Try it. Test it. Compare it. Prove it. Your nearby Authorized Cutler-Hammer Distributor is ready to serve you. Order from him today. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin.

CUTLER-HAMMER
☆ ☆ ☆
MOTOR CONTROL
C-H

☆ INSTALLS EASIER

☆ U-shaped cover removes to make working parts easy to see and reach, wide open on both sides and front. Plenty of room and light to see and to work. ☆ Unit plate construction permits removal of entire mechanism by loosening just 3 screws. A dream for quick and easy conduit work and for pulling in wires. ☆ Keyhole mounting slots at top allow hanging starter on previously driven screws. An easy one-man job. ☆ Plenty of wiring space. And straight-through wiring. All line terminals at top, load terminals at bottom. No criss-cross. And every terminal can be reached with a screw driver from the *front*. ☆ Pressure connectors on *all* terminals; no slow and tedious wire looping. ☆ Easily changed magnet coil clearly marked for voltage and frequency. ☆ Many other features.

☆ WORKS BETTER

☆ Positive, guided armature action. Movement on self-cleaning pivot bearings. No sloppy misalignment or sliding frictional drag. Quiet. ☆ Automatic armature kickout assures quick break and prevents false operation due to shock. ☆ Dust-safe vertical contacts stay clean. Heavy duty twin-break to minimize arcing. Fully confined in pressure-quench chambers, yet easily accessible and easily removable. ☆ Famous C-H Eutectic Element overload protection; accurate, simple, dependable. ☆ New 4-position overload heater coils permit adjustment within 3% of actual full load motor rating; dependable protection with fewer needless motor stoppages. ☆ New and exclusive, *three* coil overload protection now available in same standard starter structure and enclosure. ☆ Many other features.

☆ LASTS LONGER

☆ Lifetime armature pivot bearings eliminate sliding friction and wear. Smooth, quiet, dependable operation is assured over entire life of starter. ☆ Dust-safe vertical contacts stay clean, free from grit and dirt that cause burning and pitting. ☆ New light-weight, movable contact design reduces "bounce"... and the resulting arcing and burning that shortens contact life. ☆ New pressure-quench enclosure of contacts further lengthens contact life. ☆ Vacuum impregnated magnet coil, filled with new solvent-free plastic and polymerized, is moisture-proof and non-softening even under high operating temperatures. ☆ Easy inspection due to "wide-open" construction insures regular care. ☆ Life-time enclosure; baked enamel on heavy Bonderized steel.

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 30, No. 3.

THE AETNA-STANDARD ENGINEERING COMPANY

Leading Engineers and Builders of CONTINUOUS BUTT WELD PIPE MILLS

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

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Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

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Plants in Warren, Ohio • Ellwood City, Pennsylvania

H. J.
Here's a really fantastic letter!
P.W.

BANNER TOOL COMPANY

BANNER Tools DETROIT — *Fine* TOOLS FOR INDUSTRY

17243 FILER AVENUE - TWINBROOK 2-4900

DETROIT 12, MICHIGAN

June 16, 1952

Cities Service Oil Co.,
3049 E. Grand Blvd.,
Detroit 2, Michigan
Attention: Mr. P. E. Watts

Dear Sirs:

We called upon the services of your lubrication engineer, Mr. A. J. Blake, in reference to a serious staining condition which we were having with our soluble oil. He analyzed this condition and recommended one of your Chillo Oils. This oil was tried and the rust condition eliminated to our satisfaction.

To our surprise on his next visit he was dissatisfied with our tool life and suggested we use a soluble oil called "Chillo A". Now not only do we have clean machines, but tool life has been increased 20%! While in our plant he asked permission to "look around", which, of course, was granted.

We were using a tapping compound with precision ground taps in order to hold to close tolerances. We did not consider tap breakage excessive but the removal of broken taps was sometimes rather expensive. He recommended we use "Chillo 10Z". Then came the surprise of our lives! With Chillo 10Z we have gone to commercial ground taps (a 300% savings) and can still hold our same tolerances, with a sharper thread, increasing tap life a minimum of 20% plus eliminating expensive removal of broken taps!

We also have a production stamping job which required a new set of dies every month. On his recommendation we tried Chillo 10Z with these dies. Now our die life has increased to at least two months...a saving in die life of 100%, disregarding labor costs. We also increased production 200% per die sharpening!

We tried the same oil on our broaching operation and found that instead of making two cuts we can get the same results now with one. We were using one of your competitors' hydraulic oils and you told us it was a "good oil" and would give us satisfactory performance. BUT, GENTLEMEN, WITH THE EXCELLENT SERVICE YOU HAVE GIVEN, PLUS THE TIME AND MONEY SAVED, YOU MAY REST ASSURED THAT ALL OF OUR LUBRICATING REQUIREMENTS WILL BE PURCHASED FROM YOU.

Yours very truly,

BANNER TOOL COMPANY

S. F. Olesak

S. F. OLESAK

SFO:sd

We Build Complete Rolling Mill Installations

- ***Hot and Cold for Ferrous and Non-Ferrous Metals***
  SHEARS, LEVELLERS, STRAIGHTENERS, COILERS, ETC.
- ***Extrusion Plants for Steel***
  AND NON-FERROUS METALS
- ***Forging and Die Forging Plants***
- ***Deep Drawing Single and Double Acting Presses***
- ***Die Casting Machines for Aluminum and Brass***
- ***Rolling Mill***
  AUXILIARY MACHINERY

THE ROLLING MILL DIVISION
HYDROPRESS INC.
will put into operation in 1953 a steel mill installation for the National Shipyards and Steel Corporation in Manila

LOEWY

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Rolling Mills • Hydraulic Presses • Pipe Testing Machines • Special Pipe Mill Equipment • Accumulators • Pumps • Die Casting Machines

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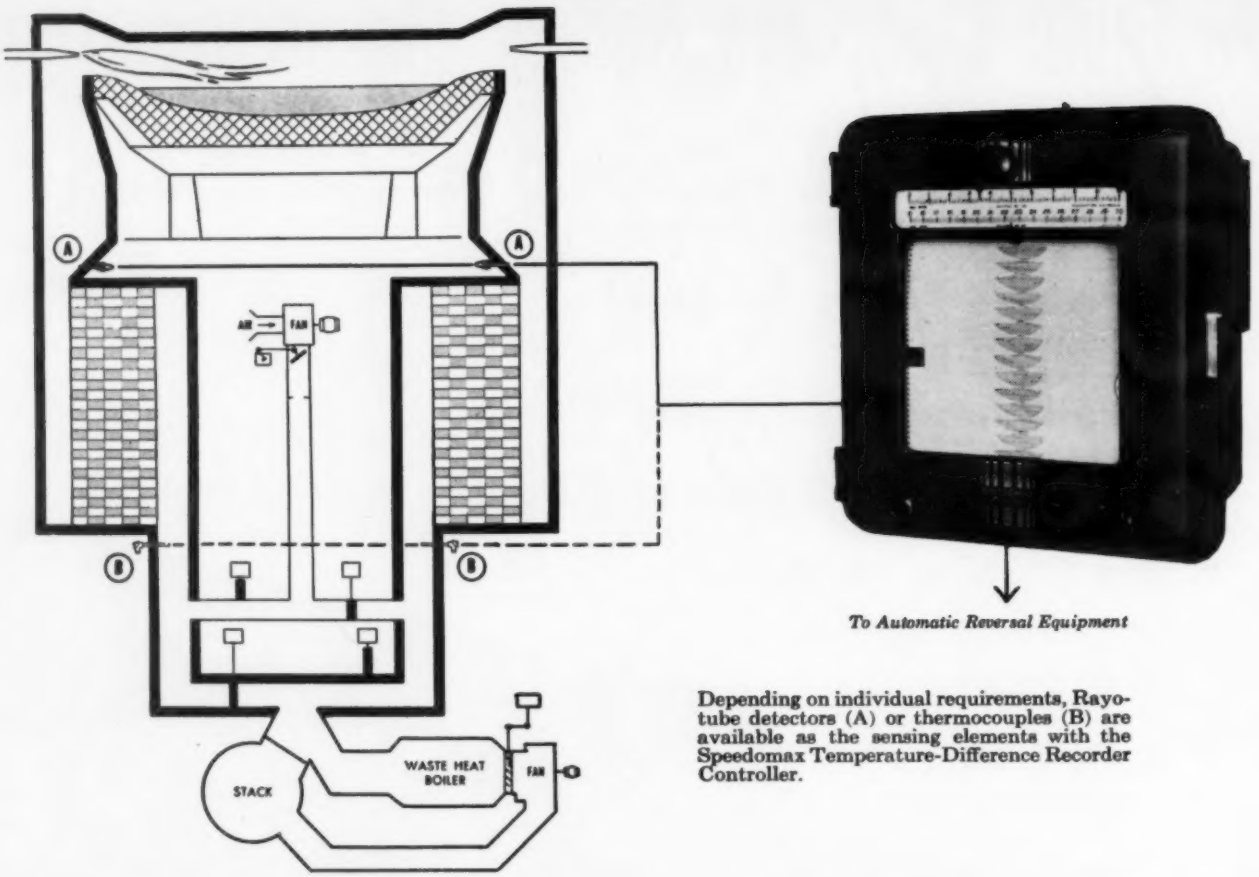

Depending on individual requirements, Rayotube detectors (A) or thermocouples (B) are available as the sensing elements with the Speedomax Temperature-Difference Recorder Controller.

Now...One Instrument Replaces Two

FOR RECORDING AND CONTROLLING OPEN-HEARTH REVERSAL

● Now the recording of checker temperatures and temperature-difference control in Open-Hearth furnaces is automatically accomplished with only *one* L&N instrument. This new Speedomax Recorder-Controller replaces the usual two-instrument arrangement . . . saves panel space . . . increases operator efficiency.

Features Include:

1. Recording of regenerator temperatures with simultaneous measurement of temperature difference.
2. Arrow-type signal lights to indicate direction of firing.
3. Either automatic reversal, or signal for manual reversal, when pre-set difference is reached.
4. An overheat safety feature which automatically reverses checkers at a pre-set temperature limit, regardless of existing temperature difference.
5. Available for use with either thermocouples or Rayotube detectors.

Highly versatile, this instrument can either be used with a complete L&N reversal system, engineered to the exact requirements of the job . . . or can be easily "tied-in" with existing control systems.

This new Speedomax Temperature Recorder-Controller makes possible Open-Hearth reversal with a minimum loss of time . . . assuring a faster heating rate . . . more uniform heat . . . better temperature balance between checkers.

For further information, contact our nearest office or write 4942 Stenton Ave., Phila. 44, Pa.

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Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for an interview at nearest of 17 L&N offices.

Jrl Ad ND46-33-643(1)

Send for free Demonstration Sheets

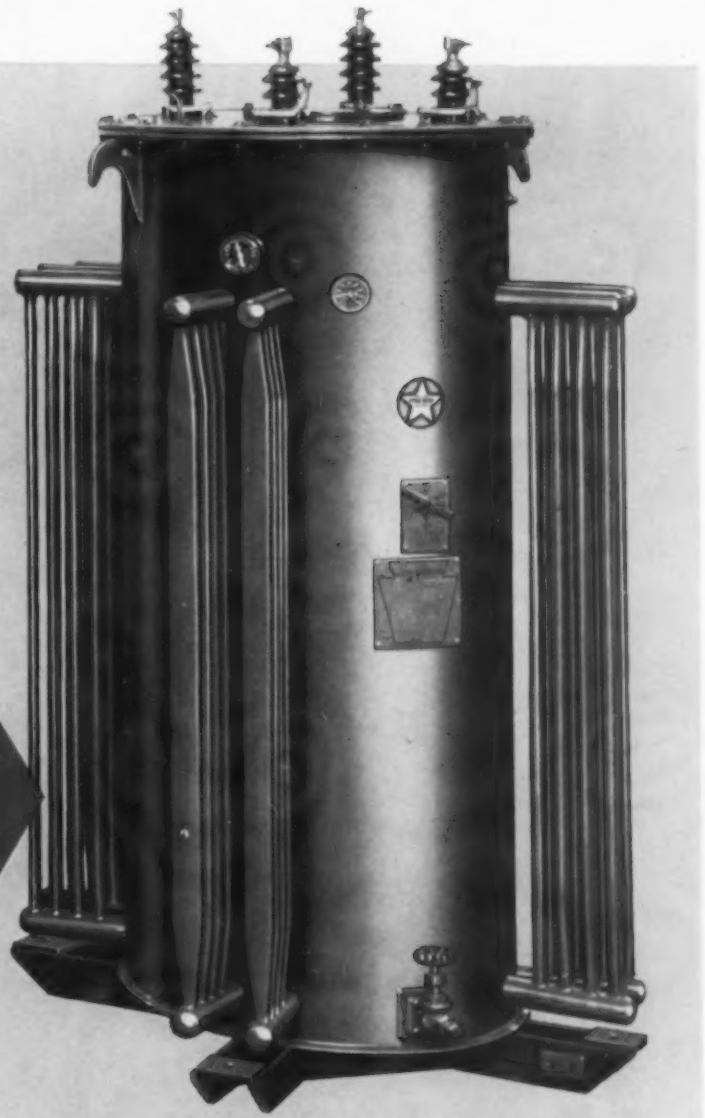
LEEDS NORTHRUP

Instruments *Automatic Controls • Furnaces*

A TON of Copper, Oil and Steel saved in NEW 500 kva POLE STAR

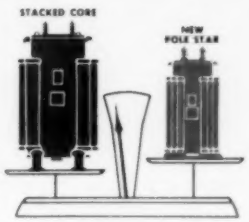
YES, the new 500 Kva Pole Star weighs 2200 pounds less than the 500 Kva stacked core transformer it replaces. This means that vitally-needed supplies of copper, steel and oil are saved in the manufacture of Pole Star transformers without sacrificing any of the efficiency or life of these transformers. On the contrary, the smaller and lighter-weight Pole Star transformers are more efficient and more economical to operate, in addition to being less costly to store and easier to install.

Pound for pound and inch for inch, the Pole Star delivers more Kva than hot-rolled steel stacked core distribution transformers. This means you can replace your small Kva transformers with larger Kva Pole Stars with little or no increase in size or weight, and, in most cases, at very low changeout cost.



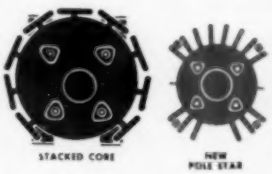
HERE'S HOW THE NEW 500 KVA POLE STAR COMPARES WITH THE OLD 500 KVA STACKED CORE TRANSFORMER

Exciting Current reduced 75%



Weight reduced 2200 pounds

Oil Volume reduced 35% 125 gallons



Floor Area reduced 20%

PENNSYLVANIA POLE STAR TRANSFORMER

Pennsylvania TRANSFORMER COMPANY

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Greater Pittsburgh District

tiny to
giant-sized bearings

with TEAM-WORK built-in every size

With every size in SKF's wide range of ball and roller bearings, you receive an extra quality – – *teamwork*. This is the ability of SKF field and home office Engineers, and SKF Distributors, to cooperate productively with you in putting the right bearing in the right place.

Result – – your equipment will improve in performance.

When it's a question of bearing *replacement*, call your SKF Distributor.

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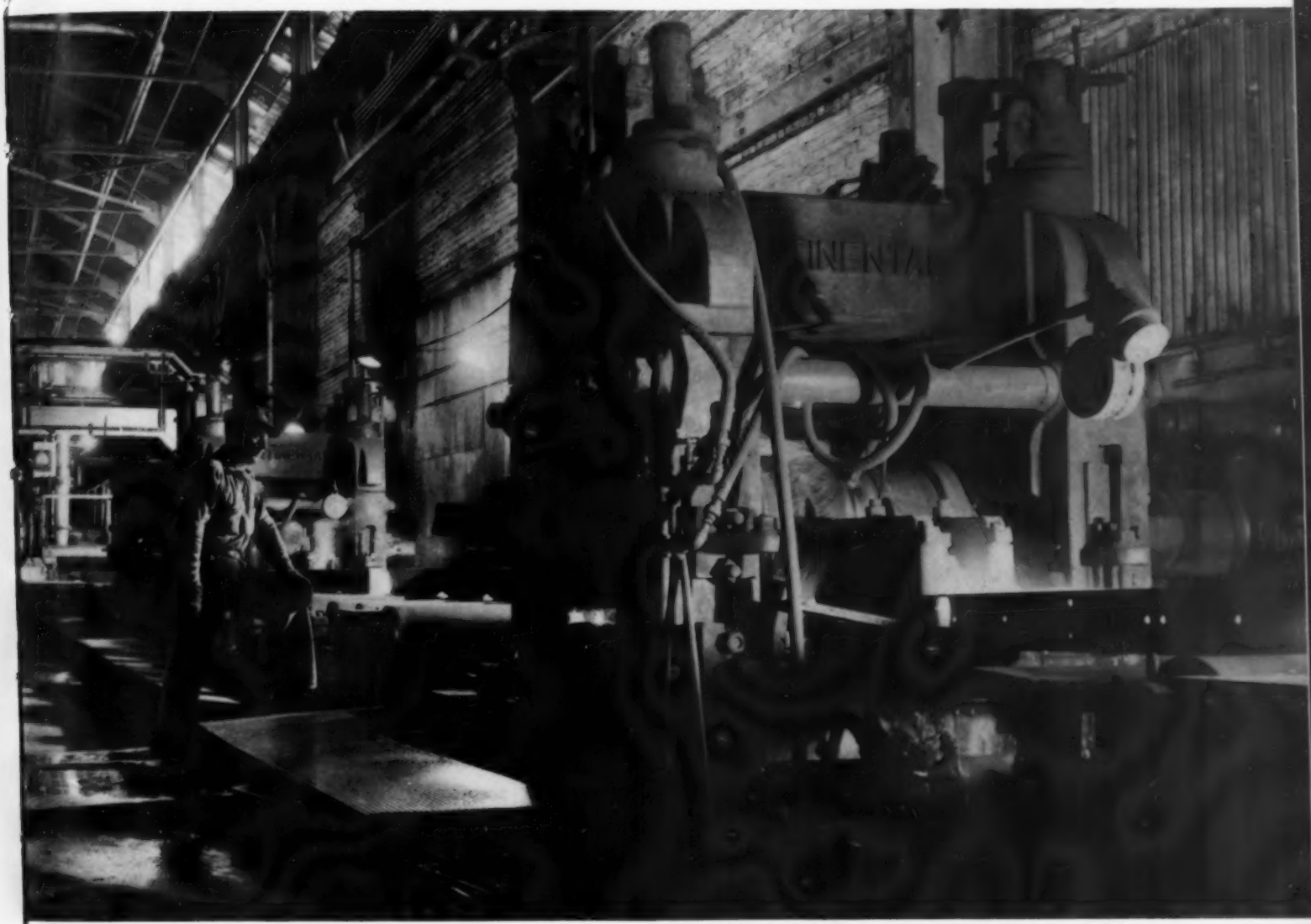
7383-A

SKF INDUSTRIES, INC., PHILA. 32, PA. – *manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.*

CONTINENTAL

CONTINUOUS BILLET and BAR MILL



Complete Rolling Mill Installations

SLABBING MILLS	Mills complete with Auxiliary Equipment	BLOOMING MILLS
UNIVERSAL MILLS		STRUCTURAL MILLS
PLATE MILLS	★ ★ ★	RAIL MILLS
HOT STRIP MILLS	CONTINENTAL CHIPPER	BILLET MILLS
COLD STRIP MILLS	ROLL LATHES	ROD MILLS
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CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

WELDMENTS—fabricated steel plate, or cast-weld design.

Plants at
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Foundry & Machine
Company

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—an Outstanding Feature of HAGAN Air-Operated Controls and Ring Balance Flow Meters

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- Fuel-Air Ratio Control
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- Gas Pressure Control
- Gas Mixing Control
- Flow Meters for gas, steam, water, and compressed air
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The production of steel presents complex metering and control problems. Wherever steel is made, Hagan Air-Operated Combustion Controls and Ring Balance Flow Meters solve them smoothly and efficiently. Simply designed and ruggedly built, Hagan equipment combines the utmost in reliability and accuracy, with a minimum of maintenance and operating expense. Applicable to all phases of the steel industry, Hagan Controls and Meters assure dependable service.

Experienced Hagan Engineers are ready to help you solve your steel mill metering and control problems. For information, write, wire, or phone:

HAGAN CORPORATION

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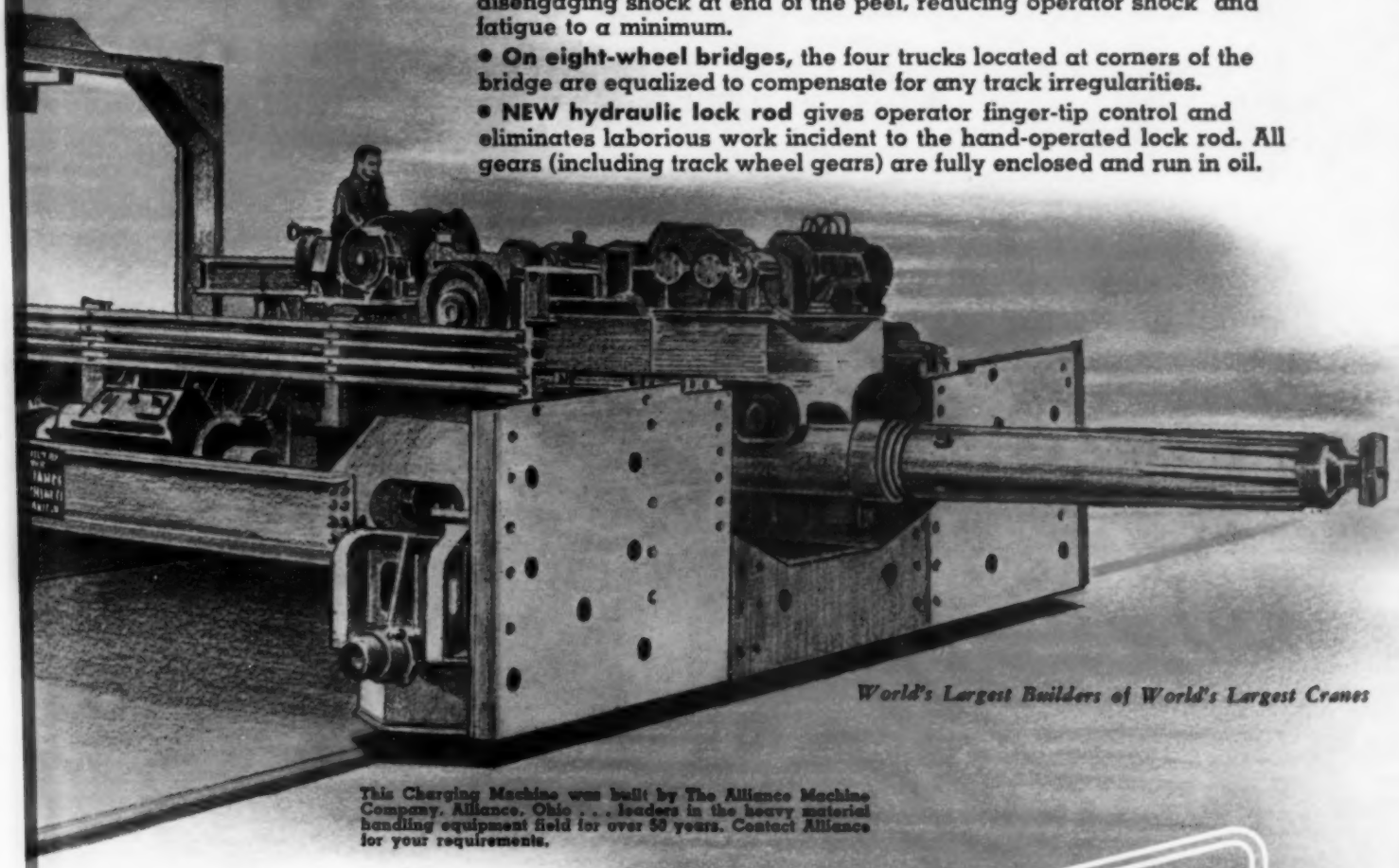
BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AERONAUTICAL
AND AUTOMOTIVE TESTING FACILITIES

Powerful, Productive and Low with Spring-Loaded Pitman

- **The NEW Alliance 12-ton, low-type open hearth Charging Machine has spring-loaded pitman so, if the charging box pushes up over scrap in the furnace, the trolley's front wheels remain on the rails. Trolley always has sufficient traction to retract peel and box from furnace.**
- **Each bridge girder** of Alliance's NEW Charging Machines consists of two wide-flanged I-beams welded to form a box section. Between webs of this box section, diaphragms are welded at 3-ft. intervals. This, plus other welded reinforcements, keeps charging machine square and rigid.
- **Machinery deck plate,** extending full length of bridge between main girder and outrigger girder laterally reinforces the main girder and helps keep charging machine square and stable under all operating conditions.
- **Stabilized, shock-absorbing wheels** operate at rear end of trolley. Two rear wheels engage upper rail; two adjacent wheels engage lower rail. Powerful springs hold wheels in contact with rails at all times. This spring suspension absorbs and disperses engaging and disengaging shock at end of the peel, reducing operator shock and fatigue to a minimum.
- **On eight-wheel bridges,** the four trucks located at corners of the bridge are equalized to compensate for any track irregularities.
- **NEW hydraulic lock rod** gives operator finger-tip control and eliminates laborious work incident to the hand-operated lock rod. All gears (including track wheel gears) are fully enclosed and run in oil.



World's Largest Builders of World's Largest Cranes

This Charging Machine was built by The Alliance Machine Company, Alliance, Ohio . . . leaders in the heavy material handling equipment field for over 50 years. Contact Alliance for your requirements.

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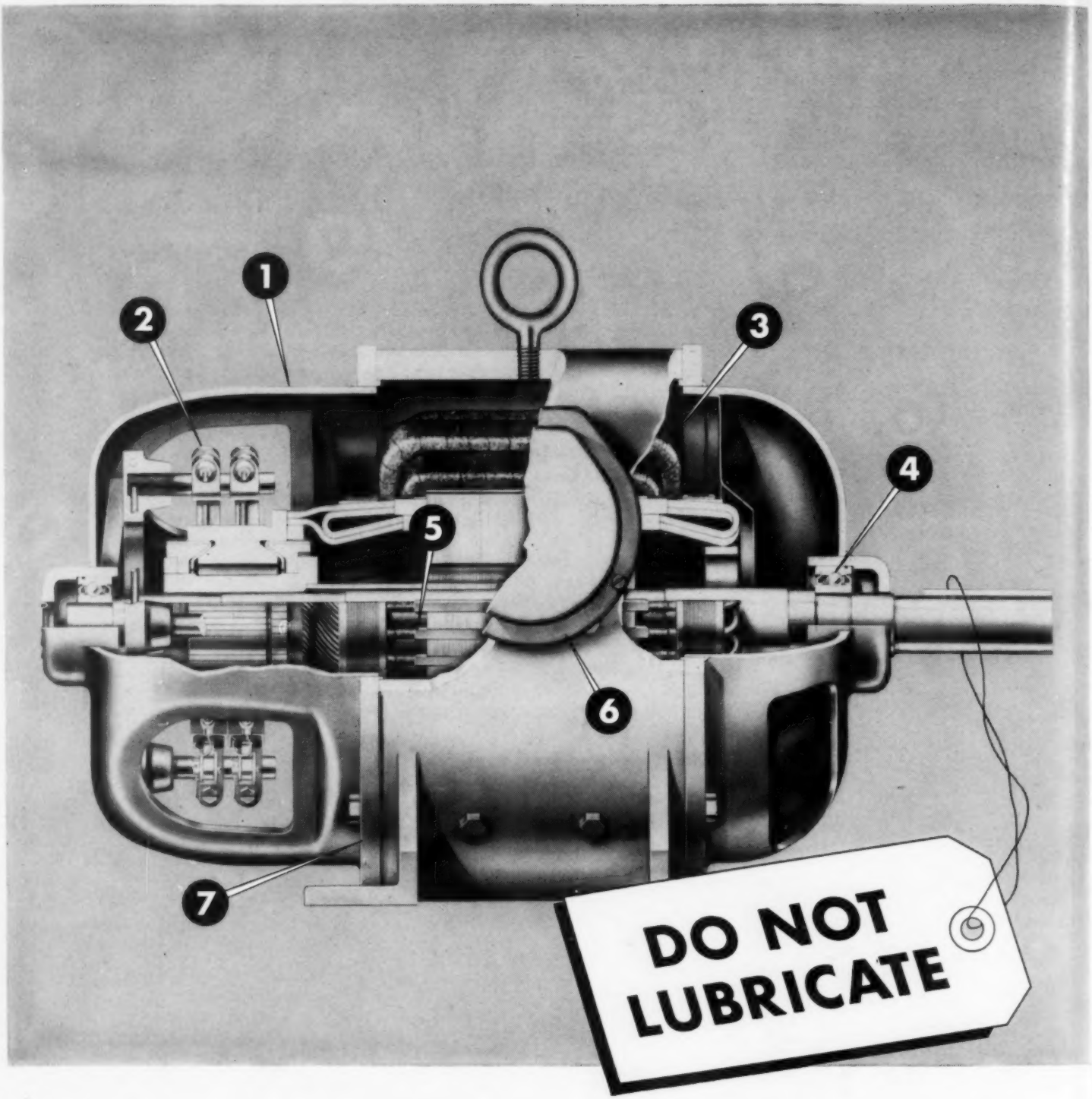
STRIPPER CRANES · SLAB AND BILLET CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES · SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION · COKE PUSHERS

THE ALLIANCE MACHINE COMPANY

Main Office, ALLIANCE, OHIO · Pittsburgh Office, 1622 OLIVER BLDG., PITTSBURGH, PA.



1. ALL-STEEL BRACKETS
2. INDIVIDUALLY REMOVED CAST BRASS BRUSHHOLDERS
3. SHELL-WOUND FIELD COILS
4. DOUBLE-SEALED PRE-LUBRICATED BALL BEARINGS
5. HEAVY-DUTY PRESHAPED ARMATURE COILS
6. STEEL-GASKETED CONDUIT BOX
7. ROLLED-STEEL FRAME

SK DEPENDABILITY
Wrapped in Steel
in the Life-Line D-C MOTOR

Thirty-nine years at hard labor—in steel mills . . . in mines . . . in a thousand and one applications—have proved the dependability of the type SK d-c motor. Now, new dependability has been added—new motor stamina . . . new freedom from maintenance . . . new value for d-c motor users.

MAXIMUM STRENGTH AND RIGIDITY—Heavy steel end brackets and rolled-steel frame stand up to the shocking, jarring blows so often encountered in rugged d-c service.

SIMPLIFIED SERVICING—Readily accessible through spacious opening in front bracket, brushholders may be removed individually. Armature coils, wound from Tufvar wire and treated in Thermoset varnish assure long life . . . reduce trouble from shorts and grounds. Double-sealed pre-lubricated bearings (proved in over half a million motors) put an end to greasing problems.

INDIVIDUAL FIELD COIL UNITS—One coil may be replaced without expense of replacing all . . . or discarding pole piece. Just slip the new coil in place . . . save repair costs.

These are a few highlights of the new, all-steel Life-Line type SK d-c motor. Get the complete facts on series, shunt, or compound motors . . . frames 203-365 . . . in 1 to 30 hp ratings. Contact your local Westinghouse representative. Ask for a copy of "D-C Motor" Booklet B-4595, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21549-A

YOU CAN BE SURE... IF IT'S
Westinghouse

Positive interlock (optional)

Short lever travel

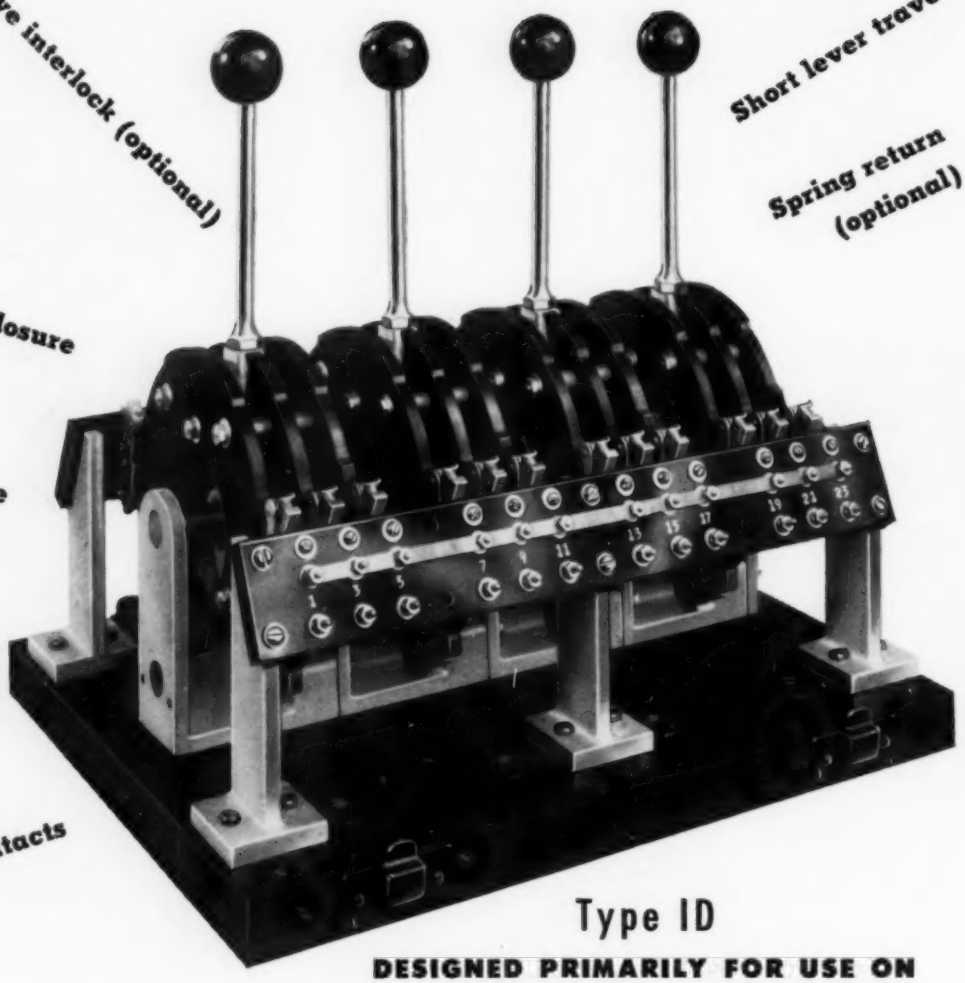
Spring return (optional)

Up to 4 switches in one enclosure

Handy to remove enclosure

Self-lubricating bearings

Fine silver double break contacts



Type ID

DESIGNED PRIMARILY FOR USE ON COKE OVEN PUSHER MACHINES

P-G master switches

Unique in design and pioneered by Post-Glover, this switch may contain up to four single Masters in one enclosure on one solid base, thereby greatly reducing longitudinal mounting space.

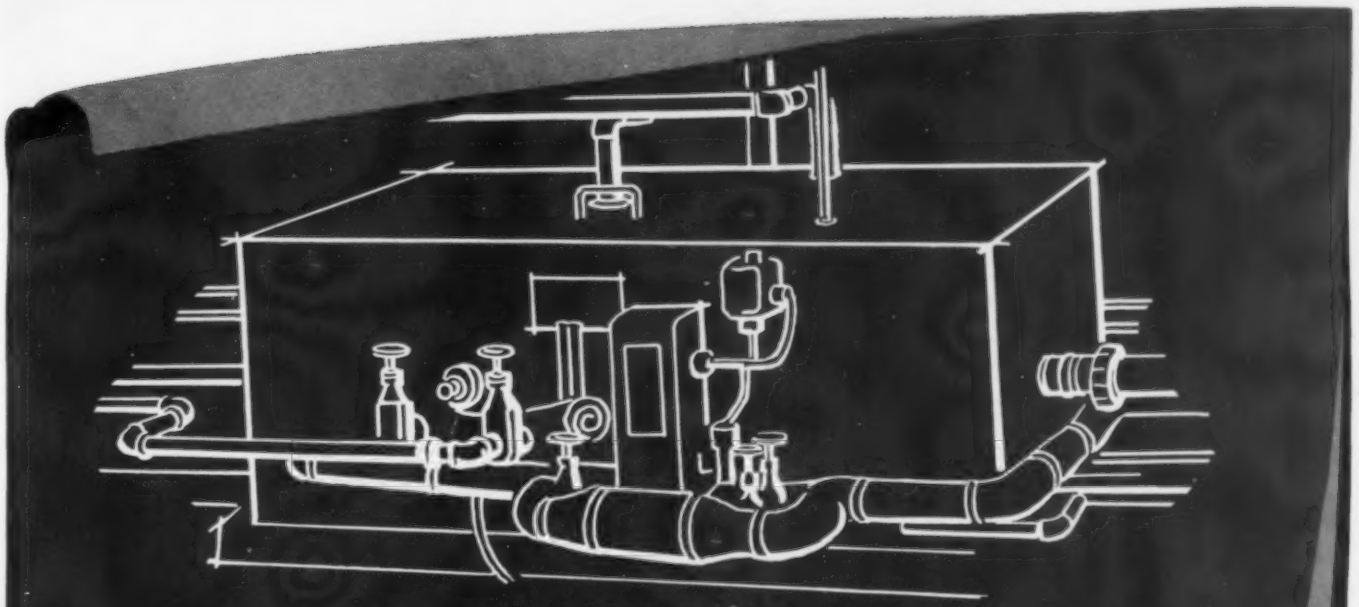
Simple, rugged and positive, the P-G patented mechanical interlock has proved in actual field service to be the answer to the coke plant engineer's request for more nearly fool-proof protection of operating equipment. It can be provided between any two or more adjacent single switches under one cover.

Write for Bulletin No. 400—Dept. E

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



In 19 Years of Lubricating
in CIRCULATING OIL SYSTEMS

BROOKS
*LEADOLENE

*LEADOLENE . . . the "I. P. Lubricant" (Indestructible pH-ilm) . . . for Industrial Needs

NEVER HAS BEEN REPLACED BECAUSE OF BECOMING ACID OR SLUDGING . . .

Among our most satisfied customers are those who use LEADOLENE in circulating oil systems. Since our laboratory checks a sample from each system every month, we know that the efficiency of none of them has been reduced because of becoming acid or sludging.

Since water does not affect the efficiency of LEADOLENE, costly centrifuging and other purifying methods are not necessary. This lubricant, with its "Indestructible pH-ilm Strength," has served for years in applications where the water content frequently reaches 35% and seldom is less than 10%. Practically all companies which use LEADOLENE in circulating systems adopted the product after some other lubricant failed.

Assure yourself of low lubricating costs and vastly increased gear and bearing life . . . by standardizing on Brooks LEADOLENE for circulating oil systems.

CASE HISTORY NO. 187

Since 1934 LEADOLENE has been used in a certain system lubricating the finishing stand pinions of a hot strip mill. Despite severe water conditions, the original lubricant still is in use after 19 years of service.

WRITE FOR a 20-page brochure, "The Brooks Oil Story" . . . or for consultation with a Brooks Engineer.

THE BROOKS OIL CO.
Since 1876

Executive Offices and Plant . . . . . **Cleveland, Ohio**
Executive Sales Offices . . . . . **Pittsburgh, Pa.**
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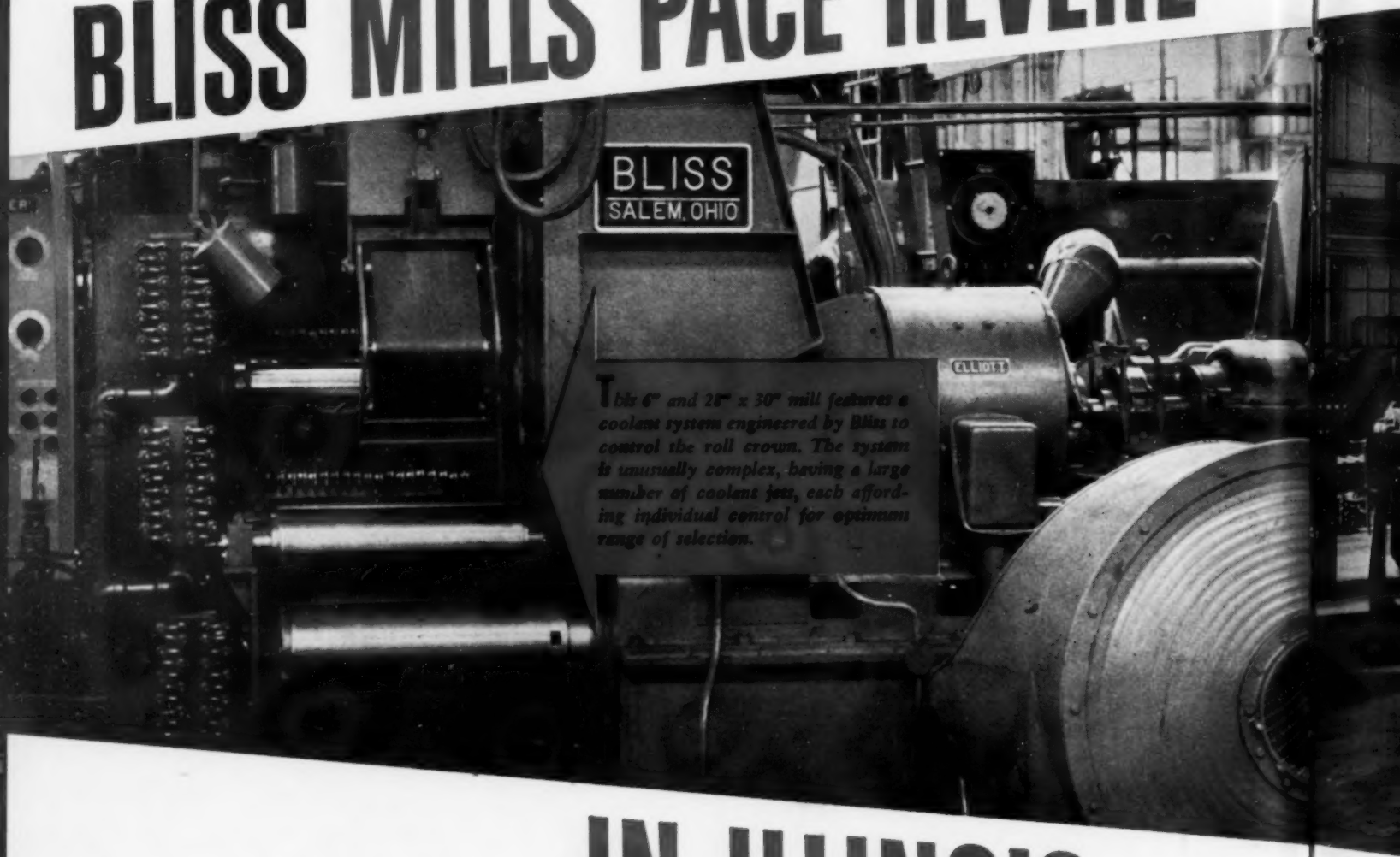
BLISS MILLS PACE REVERE


BLISS
SALEM, OHIO
ELLIOTT
This 6" and 28" x 30" mill features a coolant system engineered by Bliss to control the roll crown. The system is unusually complex, having a large number of coolant jets, each affording individual control for optimum range of selection.

IN ILLINOIS...

Revere Copper and Brass Incorporated is not one to rest on the laurels of its 150-plus years of experience and accomplishments. Revere is constantly expanding and improving its facilities.

That's why Revere's recent effort to get added rolling efficiency and capacity resulted in installation of four new Bliss mills in three different manufacturing divisions: two mills in Rome, N. Y., and one each in Chicago and Detroit.

All the Bliss units are four-high reversing mills for reducing copper and brass. Each is a wet mill having a coolant system that permits exact control of the roll crown, in addition to cooling strip. And each is equipped with expanding mandrel reels—used both for tension and pay-off—and coil buggies for each reel.

Back-up rolls are driven instead of work rolls. Since mill speed depends on peripheral speed of the back-up roll, work rolls of varying diameters (5¾" to 8") can be used without affecting operating speed of the mill.

Revere uses the mills to reduce hard copper from 0.030" to 0.015" and from 0.025" to 0.010". Both copper and brass are rolled to gages in the 25-inch width, as light as 0.004". Brass is reduced 50 to 60% between anneals.

You, too, can look to Bliss to fill your major rolling mill needs. Whether it's a hot mill or a cold mill...brass, copper, steel or aluminum...breakdown, rundown or finishing... Bliss can build it. See the complete line in our illustrated Bulletin 40—yours for the asking.

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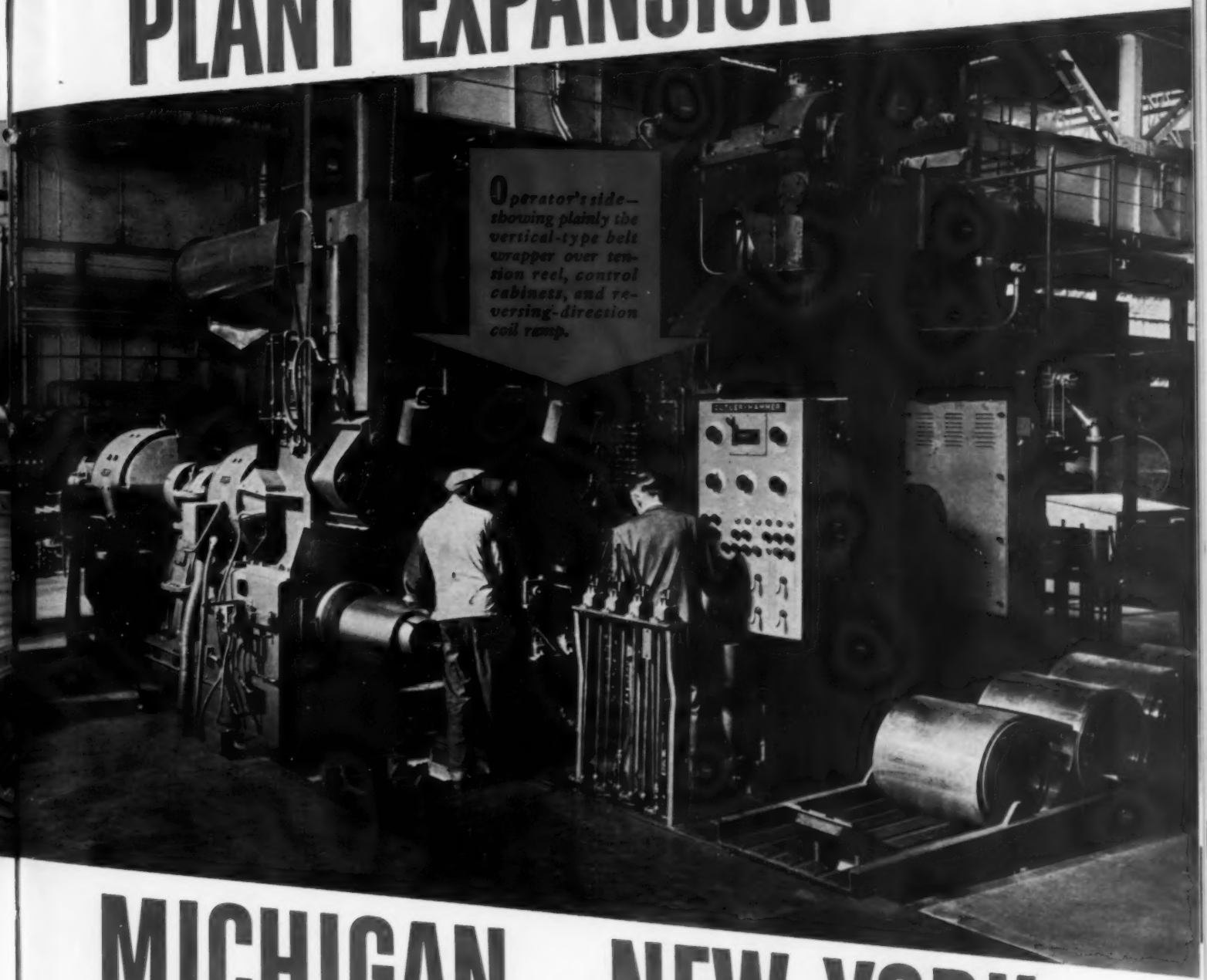
U. S. plants at Canton, Salem, Toledo, Ohio; and Hastings, Michigan

Branch offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo; and Toronto, Canada. West Coast Representatives: Moore Machinery Company, Los Angeles and San Francisco; Star Machinery Company, Seattle. Other dealers in U. S. cities and throughout the world.

PLANT EXPANSION



Operator's side—showing plainly the vertical-type belt wrapper over tension reel, control cabinets, and reversing-direction coil ramp.

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FARRELL-CHEEK

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A COMPLETE SERVICE!

FARRELL-CHEEK STEEL CO. SANDUSKY, OHIO, U.S.A.

1 LOW INITIAL COST

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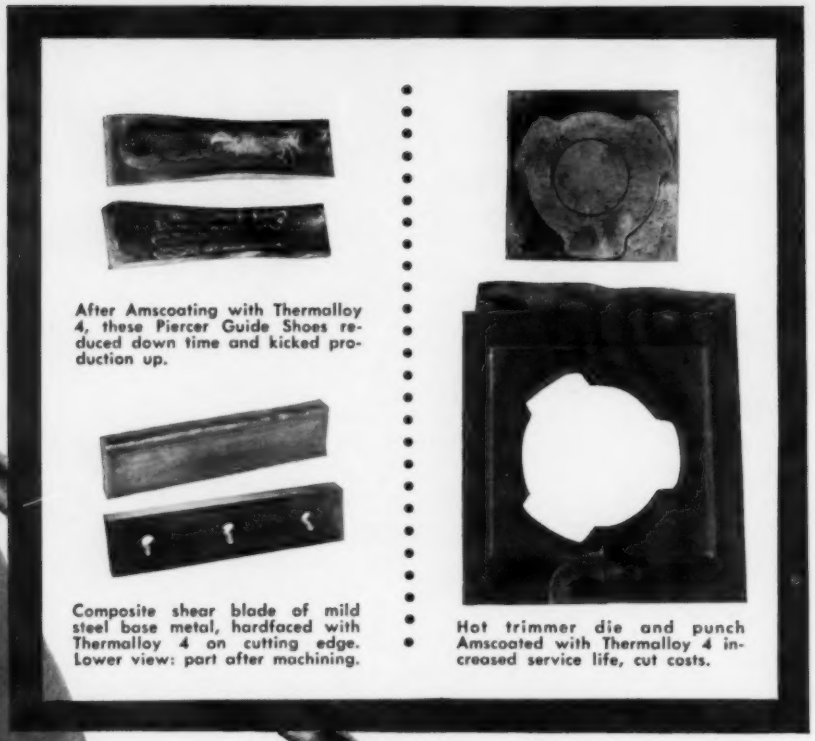
...easy to maintain

Good Reasons for Specifying EC&M Control for Skip-Hoists

In addition to low initial cost and simple, easily maintained construction, EC&M Control gives highly desired flexibility and top-notch efficiency on the straight part of the skip-incline. It also provides utmost accuracy in stopping.

When building new furnaces or modernizing existing installations, consult with EC&M, without obligation, of course.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79th STREET • CLEVELAND 4, OHIO



After Amscoating with Thermalloy 4, these Piercer Guide Shoes reduced down time and kicked production up.

Composite shear blade of mild steel base metal, hardfaced with Thermalloy 4 on cutting edge. Lower view: part after machining.

Hot trimmer die and punch Amscoated with Thermalloy 4 increased service life, cut costs.

BEAT HEAT WEAR and IMPACT with AMSCO THERMALLOY 4

If you have a wear problem involving high temperatures and requiring resistance to impact, this new Amsco hardfacing electrode can save you time and money

Elevated temperatures are tough to cope with in situations involving thermal shock, metal-to-metal wear, hot gas corrosion, high temperature oxidation—especially when you need great impact resistance. Here's where Amsco Thermalloy 4 can step in and give you longer service life, and big savings in time and money.

Supplied as both a composite coated electrode for electric welding or as a bare cast rod for gas welding, both types deposit a high-carbon stainless alloy containing chromium and nickel as the principle alloying elements. In many applications, it can replace expensive nickel base alloy materials. Thermalloy 4 is packaged in 50-lb. boxes or in 10-lb. packages in 50-lb. boxes. For detailed analyses and other pertinent information, write for catalog sheet on Thermalloy 4 or contact your nearest Amsco distributor.

AMSCOATING

THE RIGHT WAY TO SAY HARDFACING

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION

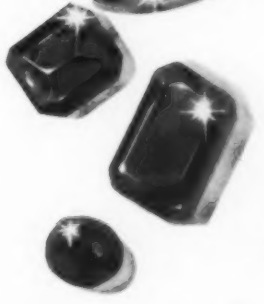
411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.

UNITED

35,000 TON FORGING PRESS

ONE of two new 35,000 ton hydraulic forging presses being built by UNITED for the USAF Heavy Press Expansion Program to help bring the United States to a commanding position in the production of modern aircraft for the armed services.



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Designers and Builders of Ferrous and Non-Ferrous Rolling Mills, Mill Rolls, Auxiliary Mill and Processing Equipment, Presses and other heavy machinery. Manufacturers of Iron, Nodular Iron and Steel Castings and Weldments.

STEEL MILL CRANES . . .

by "Shaw-Box"

Before you buy your next mill crane, investigate "Shaw-Box" Cranes built to A.I.S.E. standard No. 6 specifications. You'll find you get more crane for your crane dollar since you have less to pay for engineering. "Shaw-Box" already has standard A.I.S.E. designs for cranes ranging from 15 to 100 tons.

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SEND ALL YOUR INQUIRIES FOR CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.

Oil Immersed

motor control for corrosive and hazardous locations

Designed for use in chemical plants, oil refineries, steel mills, cement plants, etc.—in locations where the atmosphere is corrosive or hazardous—Class 1, group D locations NEMA Type *VIII* enclosures.

Rowan Type 780 KBF-1 combination starters consist of heavy duty, magnetic contactors of the clapper type giving high-speed closing and opening with positive roll and wipe action; magnetic overload relays with inverse time element provided by means of Rowan AIR-SEAL dashpot—each relay individually tested and calibrated; safety disconnect switch of the contactor type with quick make and break mechanism—equipped with Rowan time-tested AIR-SEAL fuses. Top and tank are mechanically interlocked with the safety disconnect handle with provision for padlocking operating handle in the OFF position.

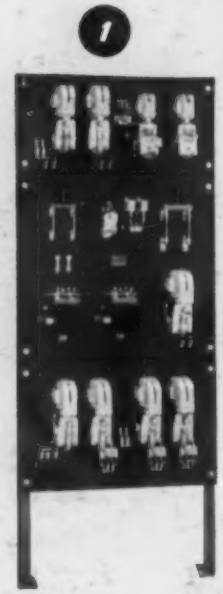
For complete information call the Rowan representative in your area.

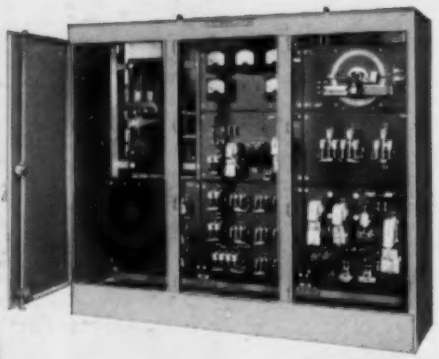
Rowan Type 780 KBF-1, Frame 100 with oil tank lowered. All operating parts are completely oil immersed and all electrical connections are at least 6" under oil.

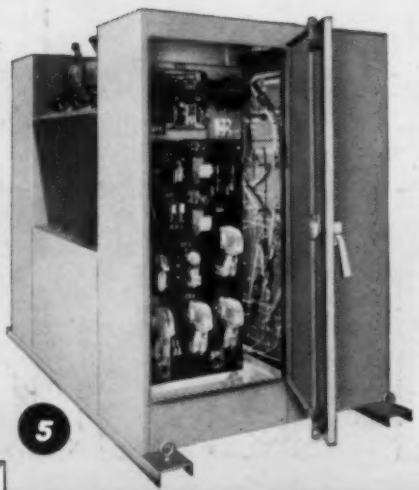
ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

STANDARD AND SPECIAL
HEAVY-DUTY D.C. MILL AUXILIARY & CRANE CONTROL







1 Dynamic Lowering Control Panel for cab-operated crane hoist. New network system gives surer hook control with only nine contactors. ***STANDARD***

2 Steel Mill Auxiliary Controller for reversing, dynamic braking service. Features include automatic acceleration by pneumatic timers, mill type overload relays, heavy duty control relays and contactors. ***STANDARD***

3 Variable Voltage Controller for continuous strip process line. With motor-operated field rheostat. ***SPECIAL***

4 Sectionalized Mill Control Panel with frame, line bussing, resistor bank. ***SPECIAL***

5 Benchboard and Control Cubicle for leveler and shear. Combination A.C. and D.C. control. ***SPECIAL***

Do you have a Control Problem?

Trained Field Engineers are at your service through Square D offices in more than 50 principal cities.

Contact the nearest Square D Field Office or write direct to the Square D Company, 4041 N. Richards Street, Milwaukee 12, Wis.

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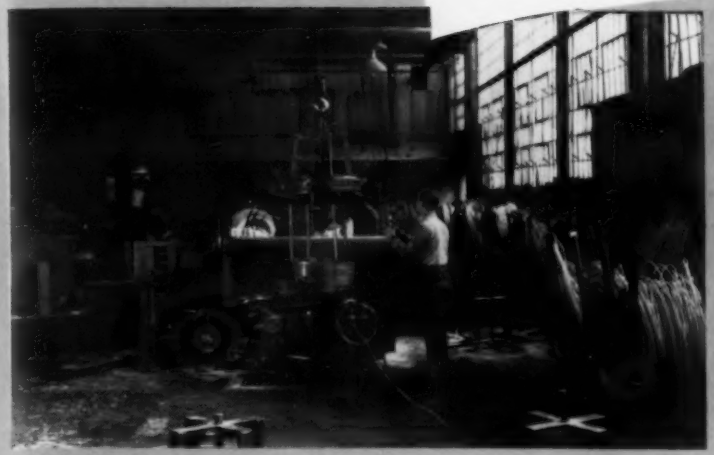
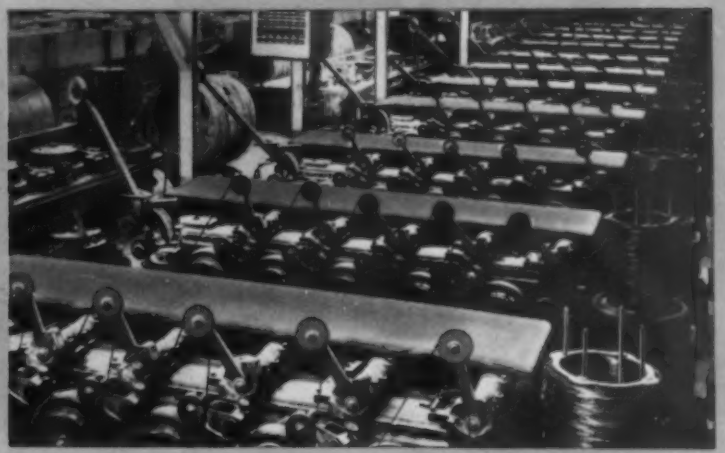


MOTOBLOC®



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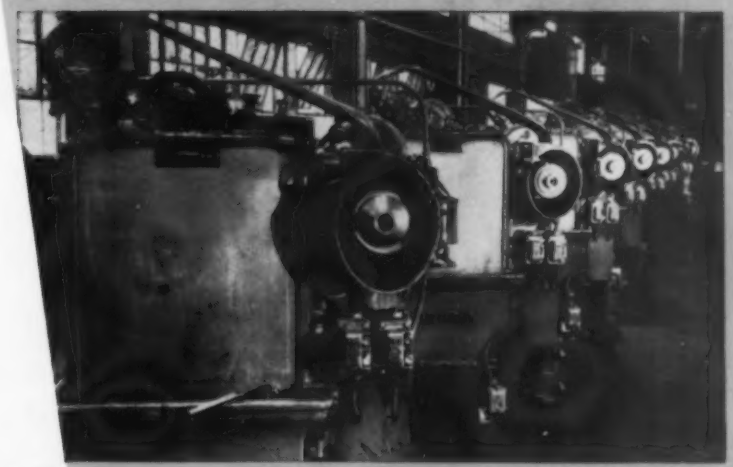
Vaughn® COLD DRAWING EQUIPMENT



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DRAWBENCHES

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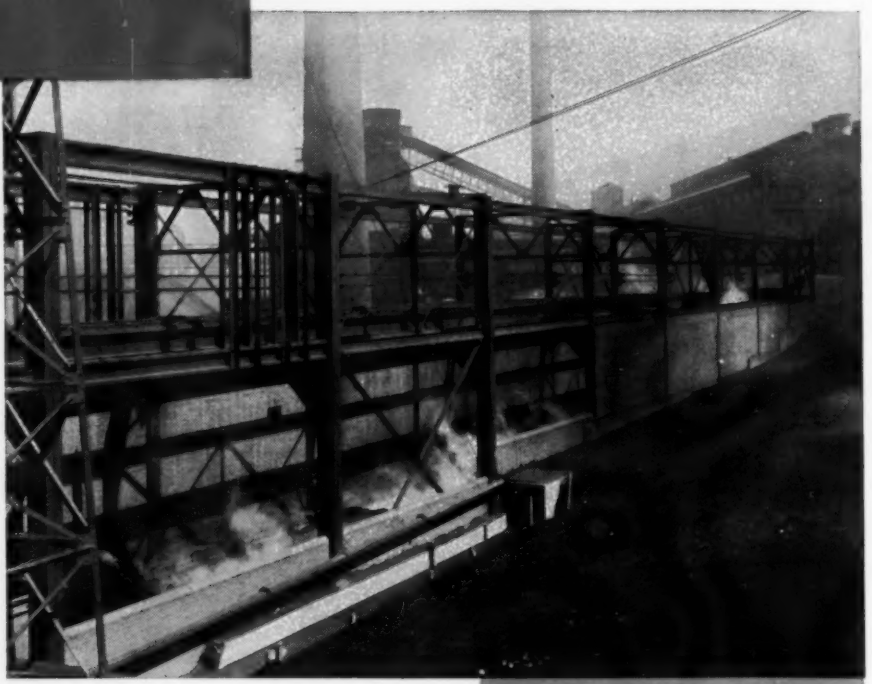
Cuyahoga Falls, Ohio, U.S.A.

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

"Quick on the Draw!"

INSUL-MASTIC
The Superior Coating

. . . protects metal equipment where coke quenching fills the air with acid vapors.



This spot is considered one of the most corrosive areas in a steel mill. That's why this crane runway is coated with INSUL-MASTIC 4010. The pit under this runway receives all the steaming, acid laden water from freshly quenched coke in a mill where the water must be used over and over. All year long gnawing vapors rise from the pit and cover the steel runway. No damage results, but look at what the vapors have done to the painted steel at the far left.

INSUL-MASTIC is the *Superior* coating that protects for a great many years. Its Gilsonite content makes it practically inert to acids. Its mica content makes it almost immune to weather. It's homogenized so that nothing settles in the drum . . . it is sprayed as it is blended. It is applied 1/16″ to 1/8″ thick in one coat.

All this adds up to a *Superior* coating . . . and this crane runway is only one of the many corrosive areas in steel mills where INSUL-MASTIC guards against the attacks of corrosion.

Write for the name of your nearest INSUL-MASTIC Representative for expert advice on protecting your equipment where coke quenching and other sources of corrosion take place.

Think first of the coatings that last!

CORROSION PROOFING
WATERPROOFING
VAPOR SEALING
INSULATION

Type "D"—The cork impregnated coating that insulates as it prevents corrosion.

4010 and granules—An attractive, weather resistant resurfacing for old or leaky masonry walls.

Insul-Mastic

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By MELVIN NORD, Patent Attorney, Detroit, Michigan

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period November 25 through December 16, 1952. . . . .

PREVENTING CRACKING OF SILICON STEEL DURING HOT ROLLING

▲ELECTRICAL steels of the grade containing from 2.0 to 2.4 per cent silicon have been unduly expensive to produce due to severe cracking during rolling of the ingots into slabs. This cracking carries over into the finished product and frequently causes a poor surface condition. The only method available to prevent such cracking has been by breaking down the ingots, reheating them and then rolling into slabs of the desired size. In this practice, the ingot is given two or three light passes on the slabbing mill, and is then returned to the soaking pits for preheating and soaking prior to rolling into a slab. This practice is quite costly due to the double heating involved and moreover reduces production due to double use of the pits and extra rolling time.

In U. S. 2,618,843, by George H. Goodsell, assigned to United States Steel Corp., cracking is avoided by increasing the phosphorus content of the steel from the 0.015 per cent maximum normally allowed up to about 0.06 to 0.08 per cent. This can be conveniently done in the ladle, either by adding ferro-phosphorus to the ferrosilicon placed on the bottom of the ladle before tapping, or by introducing it into the stream of metal during tapping.

STOCK-FEEDING HOPPER FOR BLAST FURNACES

The double-bell-and-hopper mechanism which is normally installed in the tops of blast furnaces is complicated, expensive, and difficult to maintain. In U. S. 2,619,344, by William H. Mursch, assigned to United States Steel Corp., a stockfeeding apparatus without moving parts is described. It is relatively cheap to construct and maintain, and provides a more or less continuous flow into the furnace stack. The apparatus is shown in Figure 1.

A column of stock is maintained in the top of the stack, resting on the furnace burden, and of sufficient height to prevent the escape of substantial quantities of furnace gases. As stock descends from the feeding

OTHER PATENTS OF INTEREST TO IRON AND STEEL ENGINEERS

Patent No.	Subject of patent	Inventor of assignee
2,618,840	Feed for power presses	Danly Machine Specialties, Inc.
2,618,845	Method of making tubes	Bert L. Quarnstrom
2,619,030	Adjustable stamping machine for marking hot-rolled products	United States Steel Corp.
2,619,176	Bloom cutting machine	United States Steel Corp.
2,619,341	Heat-treating furnace	Sunbeam Corp.
2,619,715	Cladding mild steel with chromium alloy steel	Colvilles, Ltd.
2,620,174	Billet heating furnace	Allegheny Ludlum Steel Corp.
2,620,267	Metallurgical flux made by briquetting fines resulting from the mining of fluorspar	Frederick E. Kern
2,620,268	Use of sponge iron impregnated with carbon as the recarburizing agent in steel manufacture	Jean Charles Fourmanoit
2,620,310	Salt bath for quenching of steel	Deutsche Gold-und Silber-Scheideanstalt Vormals Roessler
2,620,496	Descaling and brushing machine for rough-drawn wire	Societe Metallurgique de Gorcy
2,620,629	Hydraulically operated jaw crusher	Kenneth Gauldie
2,620,690	Roll-forging machine	Crucible Steel Co. of America
2,620,931	Steel bar conveying apparatus	Love Winston
2,621,033	Conveying disk for heat-treating furnaces	Driver-Harris Co.
2,621,119	Stainless steel melting process	Armco Steel Corp.
2,621,234	Instrument for measuring carbon content of steel by magnetic properties	United States of America
2,621,394	Apparatus for shaping ingots into a rectangular cross-section	Luigi Toppi
2,621,717	Annular torch head for flame hardening machines	The Cincinnati Milling Machine Co.
2,621,806	Machine for feeding metal sheets from the top of stacks	Robert J. Van Schie
2,621,860	Feed plate for gyratory crushers	Nordberg Manufacturing Co.
2,621,915	Cupola for foundries and steel works	Adolphe-Maurice-Charles Poumay
2,622,063	Electrolytic production of iron	Erik Gustaf Robert Angel

column into the stack by gravity, it is replenished at the top. Suction is maintained around the column about halfway up, to carry away any small amount of gases which may seep through the stock in the column. The gases leave through pipe 36a. A spreader cone 31 is fixed in the bottom of the hopper so as to leave an

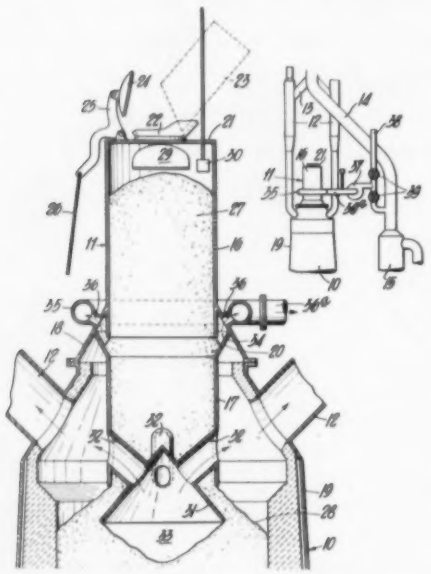


Figure 1

open space between it and the hopper entirely around the circumference of the hopper. An annular exhaust chamber surrounds the hopper.

CLEANING BRICK CHECKERWORK

The working surfaces of the checkerwork of the regenerator of an open hearth furnace become incrusted with iron oxide deposits consisting mainly of particles of Fe_2O_3 and Fe_3O_4 cemented together. These deposits gradually become of considerable thickness, thereby reducing the efficiency of the checkerwork. Heretofore the methods of coping with these deposits has been either dismantling the checkerwork and rebuilding it with clean brick, or cooling the checkerwork sufficiently to permit entry and manual cleaning by scraping or chipping off the deposits.

In U. S. 2,621,136, by Paul H. Cardwell and Charles M. Loucks, assigned to The Dow Chemical Co., a method of removing the iron oxide incrustations without the need for dismantling or cooling the checkerwork is disclosed. An aqueous solution of oxalic, citric, or acetic acid is sprayed on the checkerwork through

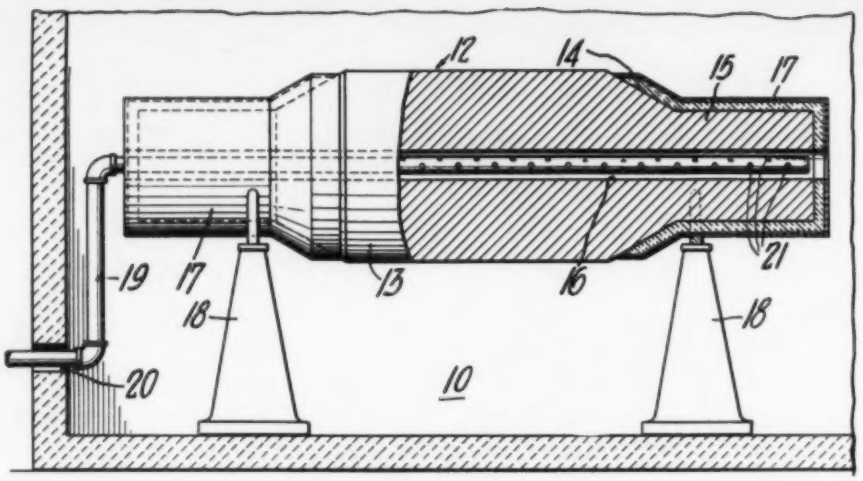


Figure 2

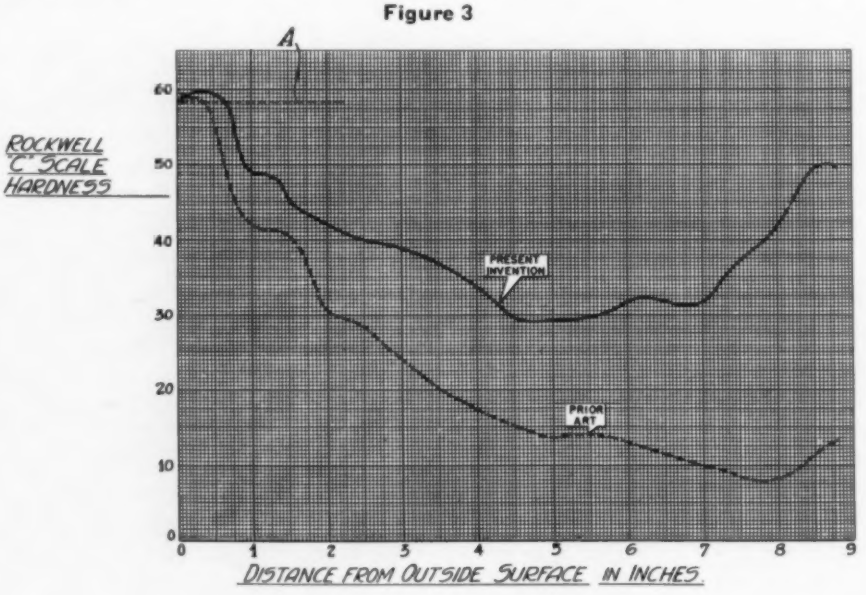
a piece of pipe which can be moved to all parts of the regenerator. A concentration of 8 per cent is satisfactory. The effect of the solution is to disintegrate and slough off the deposits, which drop onto the floor of the tunnels below the checkerwork, forming piles which may be readily removed. The checkerwork is treated while it is hot.

METHOD OF HARDENING ROLLS

In U. S. 2,619,439, by James S. Rennick, assigned to United States Steel Corp., a new method of hardening steel rolls is presented which results in a deeper hardening, with consequent longer life of the roll. In this process, the roll 12 is supported within a furnace 10 on stools 18, as shown in Figure 2. The outside of the shoulders 14 and necks 15 are shielded with insulating material (asbestos covered with sheet metal) to prevent their being heated to the critical temperature. A perforated pipe 19 extends through the bore 16 of the roll. A stream of cooling gas (for example compressed air) passes through the pipe and impinges on the inner surface of the roll at the bore. The furnace heats the entire outer surface of the roll body at one time uniformly above the critical temperature to about 925 C. The streams of cooling gas maintain the bore surface somewhat below the critical temperature, at about 740 C. The entire roll is then quenched with water.

The results are indicated in Figure 3. The dashed line A indicates the lowest usable hardness for steel work rolls, 58 Rockwell C. As indicated, the process described in the present invention increases the depth of usable hardness from 3/8 to 5/8 in., while leaving the interior soft and tough.

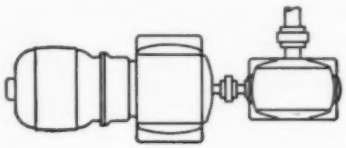
Figure 3

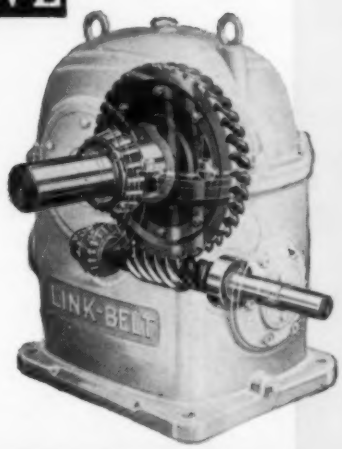


How to change even complex speed reduction problems into *simple* ones

WORM GEAR DRIVE

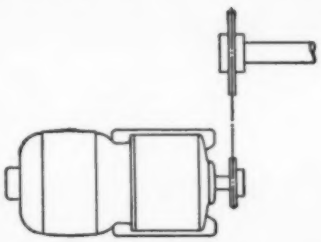
WORM GEAR and P.I.V. variable speed drives are shown direct-coupled. Link-Belt worm gear drives are available in 3.1:1 to 8000:1 reduction ratios—1400 to 123,000 in. lbs. torque—0.22 to 564 output shaft rpm. Ask for Book 2324A.

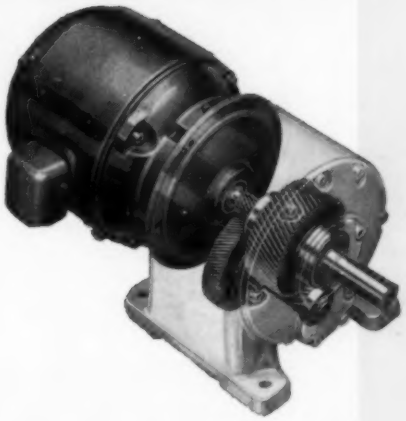




GEARMOTOR & HELICAL GEAR DRIVE

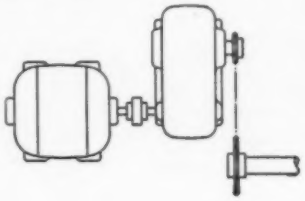
GEARMOTOR is shown with roller chain drive. Link-Belt Helical Gear Drives, Gearmotors and Motogears are available in 6.2:1 to 292:1 reduction ratios—1 to 30 hp—6 to 280 output shaft rpm. Ask for Books 2247 and 2451.

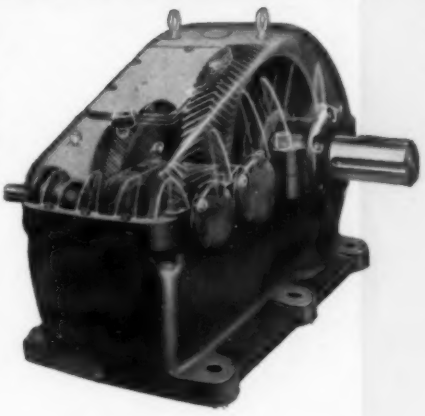




HERRINGBONE GEAR DRIVE

HERRINGBONE GEAR DRIVE is shown connected by flexible coupling to motor and with roller chain take-off. Link-Belt Herringbone Gear Drives are available in 2.84:1 to 326:1 ratios—0.4 to 2480 hp—2.2 to 623 output shaft rpm. Ask for Book 2519.





Get the proper drive combination that best meets your requirements from the broad LINK-BELT line

In addition to matching a wide range of requirements for ratio, hp, loading conditions and similar factors—Link-Belt enclosed gear drives offer you other benefits. When your Link-Belt representative selects a helical, herringbone or worm gear drive, you have no worries about coordinating it with your other components.

For Link-Belt builds a complete power transmission line. There's no need to exchange drawings with a third person to calculate chain, sprocket, coupling, bearing or even shafting requirements. You can get all these from one source . . . each pre-engineered for perfect fit.

Next time you're faced with a speed reduction problem, take it to power transmission headquarters. There's a Link-Belt sales office or distributor near you. Call today for complete engineering information.

LINK-BELT

ENCLOSED GEAR DRIVES

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

These Metalworking Methods Save Time and Money

These six methods for keeping production geared to current demands are typical of the many processes and products available through LINDE. Not shown, but equally available to LINDE customers, is the invaluable combination of knowledge, technical skills, and wide practical experience that makes such developments possible.

Whatever you do with metals, there is a good chance that LINDE know-how, show-how, and equipment can help you do it better, quicker, or cheaper. Telephone or write our nearest office today.

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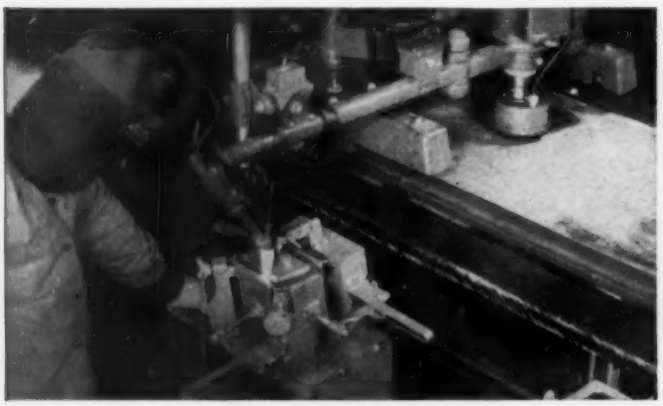
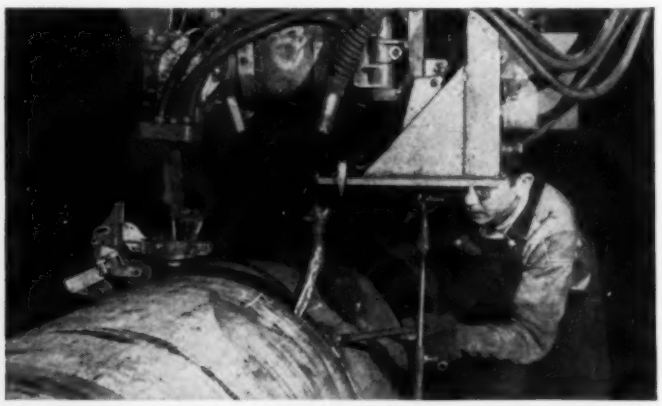
In Canada: Dominion Oxygen Company, Limited, Toronto

(Left) Flame-hardening gives added service life to parts by providing a hard, wear-resisting surface on a tough, ductile core. (Right) Oxygen-cutting equipment easily slices steel up to 60 in. thick. A 30-in. cut through this 45-in. thick ingot took only 15 minutes.



HELIARC welding in a protective shield of argon or helium gas easily joins hard-to-weld metals such as aluminum, magnesium, stainless steel, and copper alloys. Absence of flux and spatter reduces cleanup and finishing costs.



UNIONMELT welding, a mechanized electric process, joins metals of any thickness without sparks, spatter, smoke, or flash. Welding speeds as much as twenty times greater than by other similarly applicable methods are common.

Powder-scarfing halves conditioning costs on stainless steel. One 8-hr. shift, using two blowpipes, easily powder-scarfs 22 to 24 ingots of 1,000 lb. each.

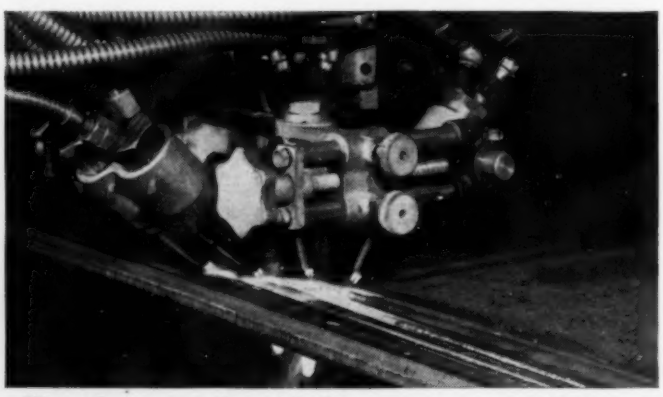


Plate-edge preparation with OXWELD apparatus makes it possible to cut steel plate to size and bevel the edges for welding in one, quick, oxygen-cutting operation.

Linde Trade-Mark

Products and Processes for MAKING, CUTTING, JOINING, TREATING, AND FORMING METALS

The terms "Heliarc," "Linde," "Oxweld," and "Unionmelt" are registered trade-marks of Union Carbide and Carbon Corporation.

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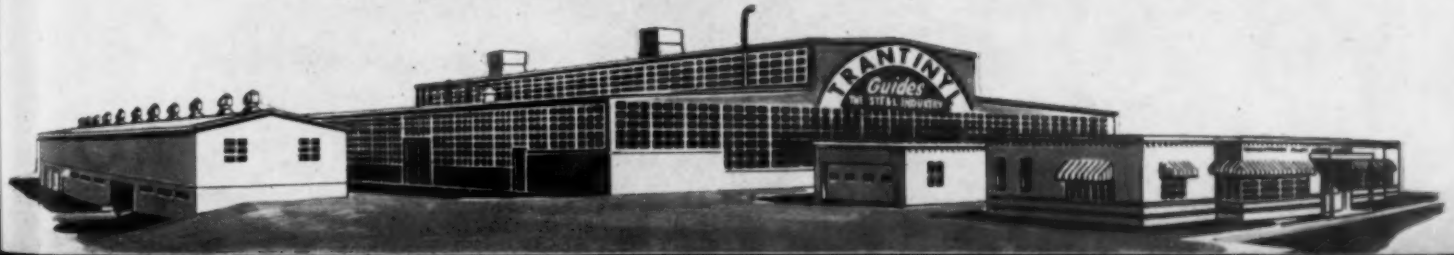
guides the steel industry



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ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc.
ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

DOUBLE PROTECTION FOR BEARINGS

1. Keeps oil and grease in

2. Keeps dust, dirt and water out

Bearings *last longer* and require *less maintenance* when they're protected by Garlock KLOZURE Oil Seals. These superior oil and grease seals keep the lubricant sealed *in*—keep dirt and contaminating materials locked *out.*

Garlock KLOZURES are produced in a wide range of sizes including Metric to fit standard International Millimeter ball and roller bearing housings. *For complete information write for Klozure Catalog No. 10.*

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Klozure*
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For all types of bearings

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For those applications for which none of our regular KLOZURE models are suitable we design and manufacture oil seals of many special types. Examples of such special constructions are . . . small seals for needle bearings . . . seals for self-aligning or spherical bearings . . . and heavy duty seals as illustrated at the left for steel mill roll necks or other shafts of large diameter. If you have a bearing seal problem let our experienced technical staff solve it for you.

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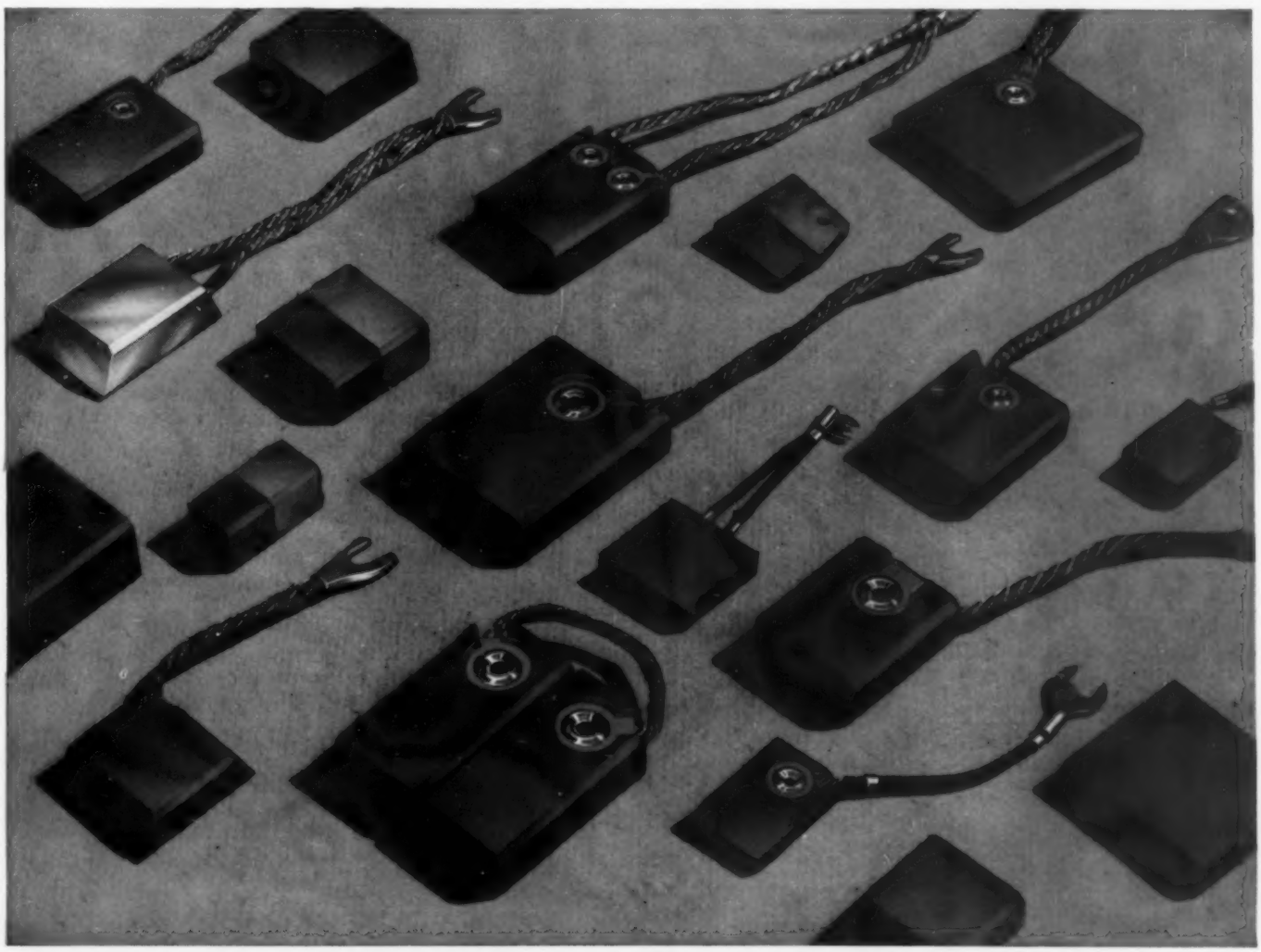


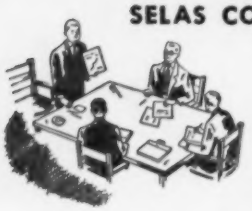
90-B

THE UNITED STATES GRAPHITE COMPANY

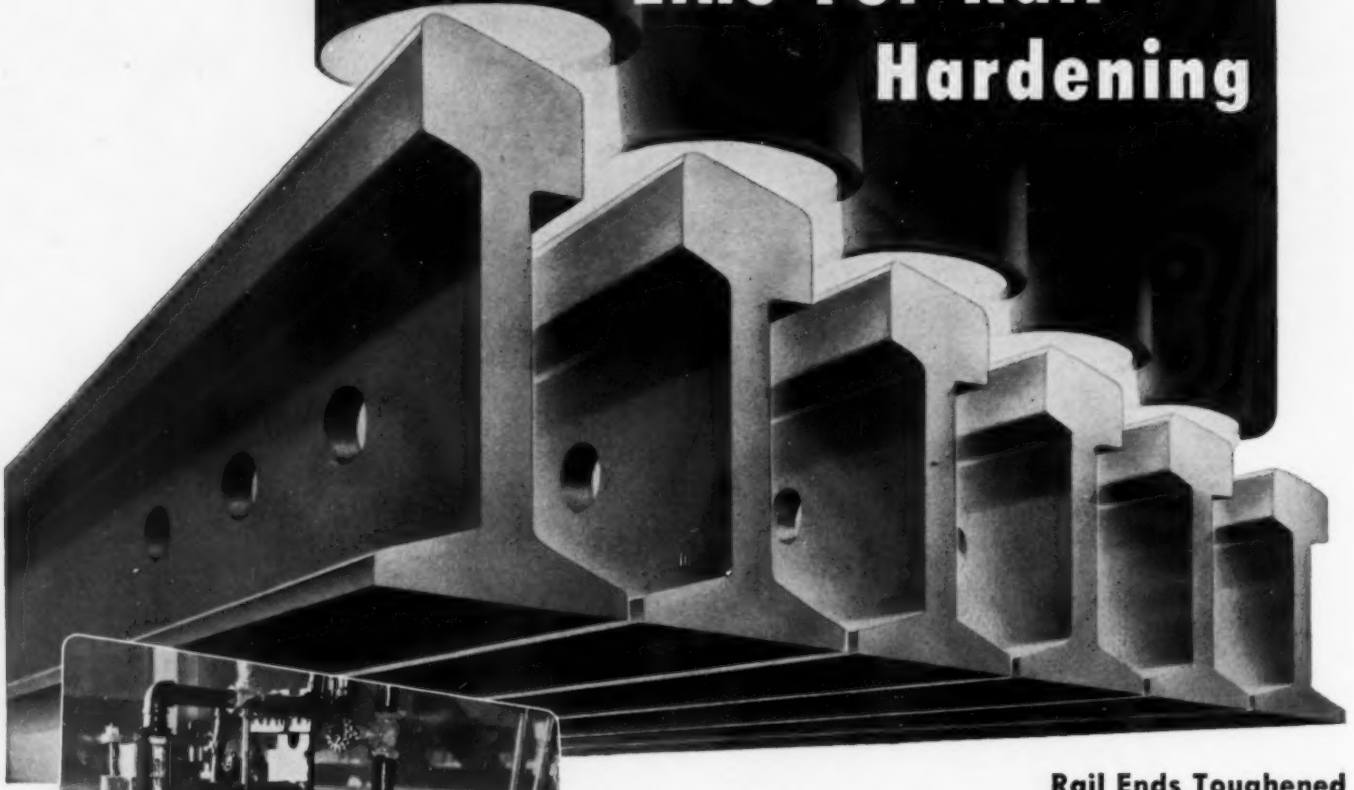
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

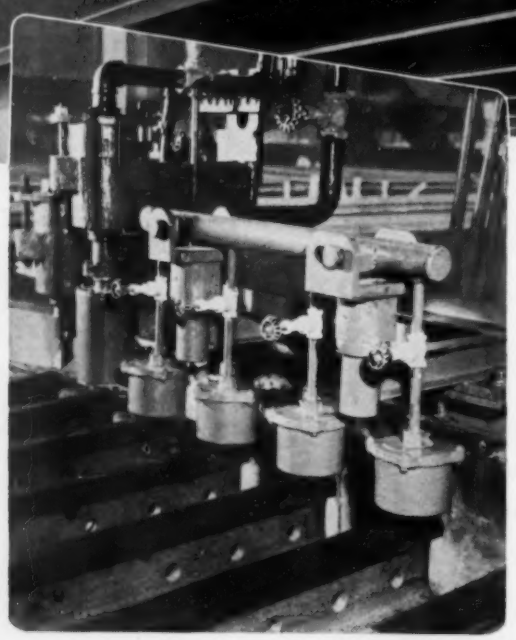
ANOTHER EXAMPLE OF

SELAS COOPERATIVE ENGINEERING



Precision Production Line For Rail Hardening





Rail ends progress automatically under each radiant burner. Final heat of 1600° F. and then air quenched under 100 lb. pressure.

Rail Ends Toughened Automatically In Minutes With Selas Radiant Gas Heat

Longer life for the rails, less maintenance for the railroads and more comfort for the passengers result from a completely automatic rail hardening process, cooperatively developed by Selas and steel mill engineers.

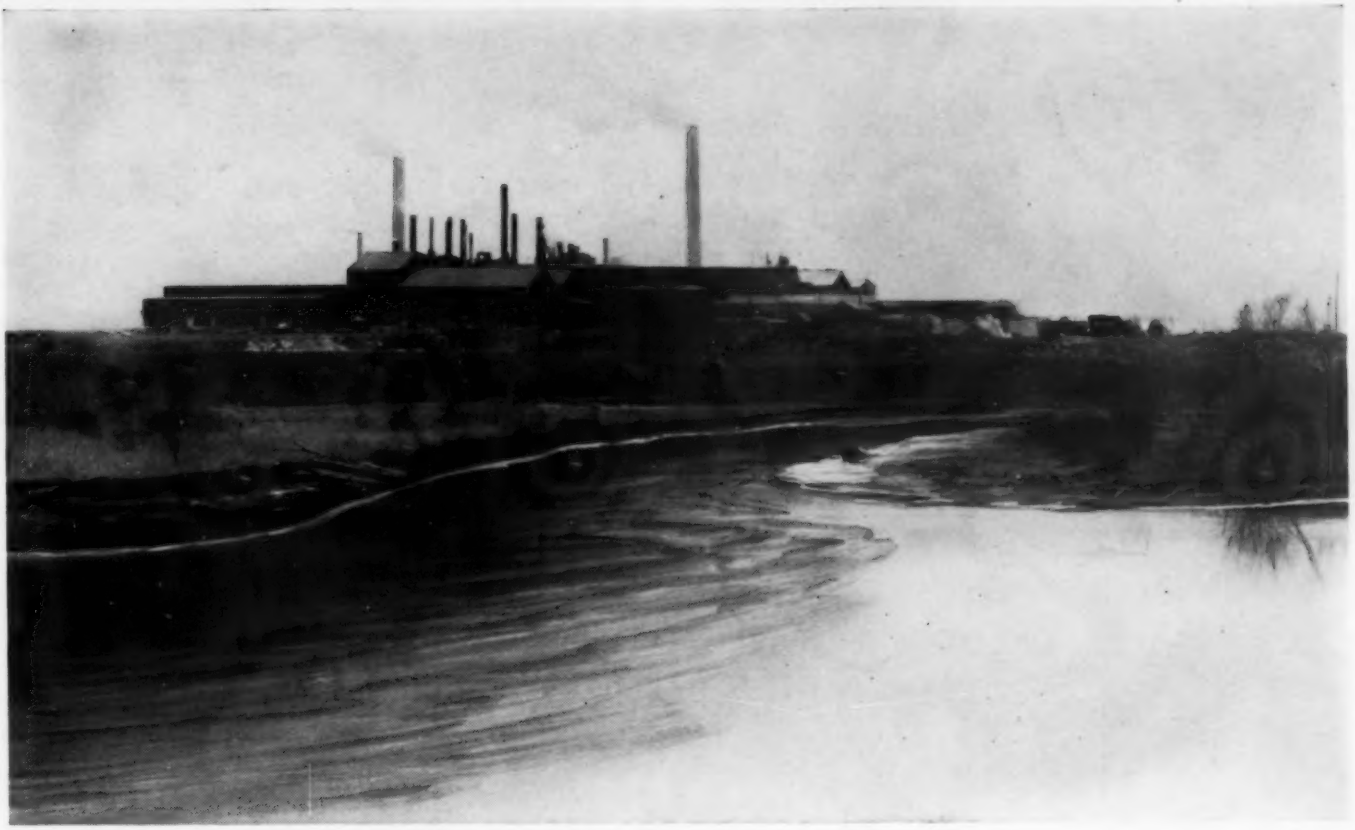
A line of radiant burners combines high temperatures, automatic operation, precise controllability and protective atmospheres to produce the finest end-hardened rails. Exact timing devices keep rail ends beneath each burner to reach the precise heat in a matter of seconds. Four heat elements bring temperatures to 1600 degrees F. Then a sudden blast of cold air under 100 pounds pressure provides the toughening cooling which hardens the steel.

This is just one of hundreds of examples of how Selas Engineers working throughout the metal industry have speeded up heat treating, metal fusion, brazing, forging and other operations Let them help you in your metal processing. Write for information about the process in which you are interested.

SELAS

CORPORATION OF AMERICA • PHILADELPHIA 34, PENNSYLVANIA

Heat Processing Engineers for Industry • Development • Design • Manufacture



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● The disposal of industrial wastes without stream pollution calls for careful planning and continuous vigilance.

That's where Bailey Meters and Controls come in. We measure the flow and pH of sewage, sludge, and industrial wastes flowing in open channels or pipe lines. These and other factors, such as levels, rates of chemical feed, and flow of air, may be co-ordinated into a completely automatic system for the treatment and disposal of waste materials.

When you want fast, complete and authoritative answers to the measurement and control aspects of your waste disposal problems, reach for your phone and call your local Bailey Engineer. Offices in all principal industrial centers.

P-24

BAILEY
OPEN CHANNEL METERS

These indicating, recording and integrating meters are suitable for measuring industrial wastes, sewage, sludge, corrosive liquids, and irrigation water flowing in all types of open channel primary metering devices, such as Venturi flumes, weirs, or nozzle flumes. Electric or pneumatic telemetering permits location of receivers wherever desired. Ratio of flows and chemical feeds may be controlled automatically.

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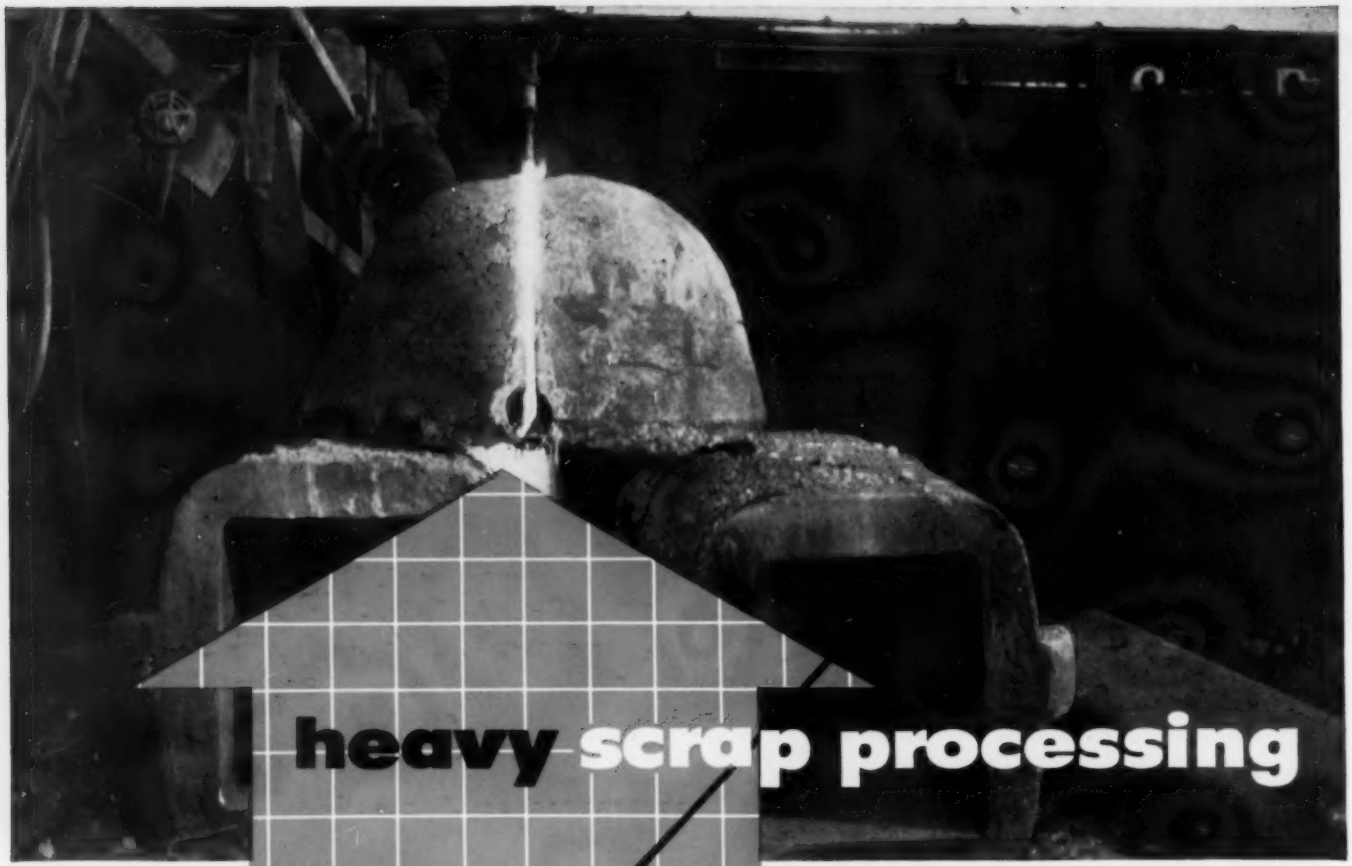
PRESSURE · LEVEL
GAS ANALYSIS · RATIO



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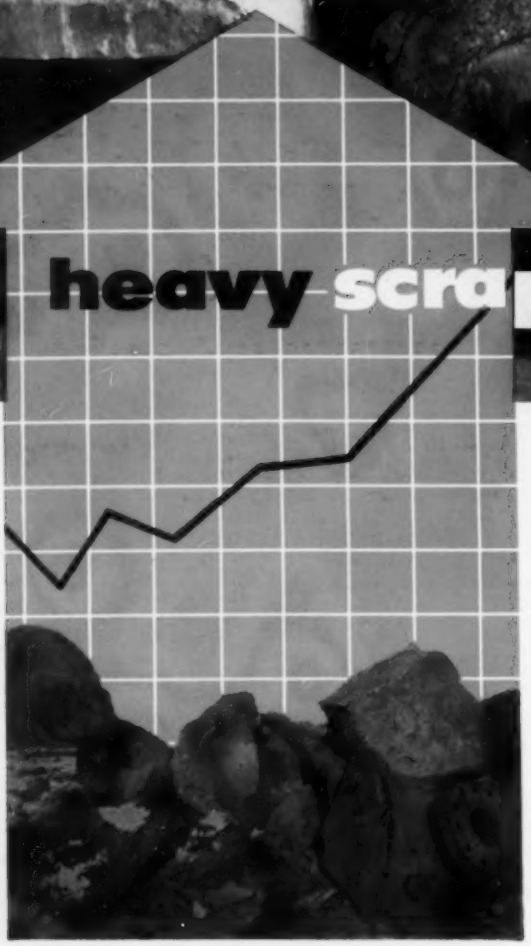

Steel and cast iron sections cut to charging box size

AIRCO TECHNICAL REPRESENTATIVES faced this problem in a large Eastern Steel Mill: How to increase scrap tonnage per man hour at lowered cost? Our recommendation: An Airco No. 41 Radiagraph gas cutting machine fitted with an Airco Style 6740 torch (shown above). Result? Tripled tonnage — all of it cut to charging box size . . . as buttons are cut down in one-third of the time! This technical advice and assistance is available to *every* Airco customer. If you have welding or cutting problems that affect *your* rate of production . . . ask us!

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F&Ym EQUIPS THE NATION'S STEEL MILLS *to Speed Production*

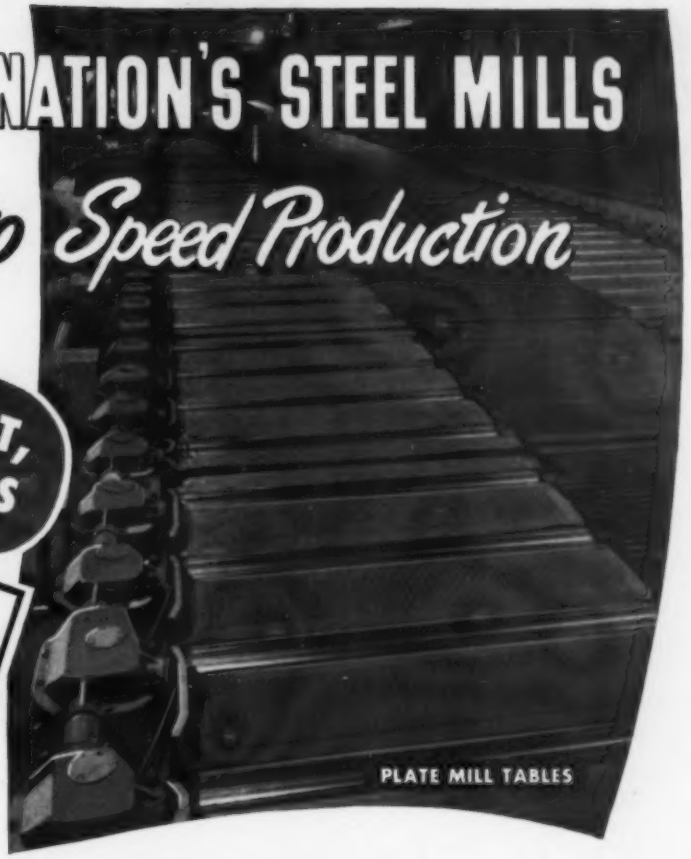
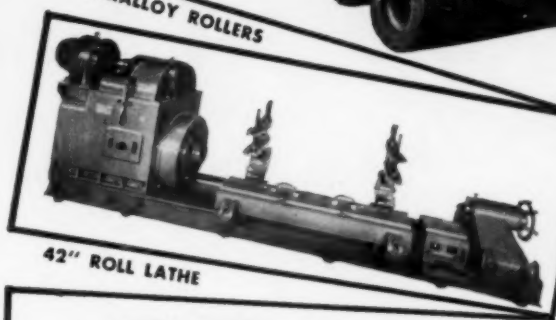
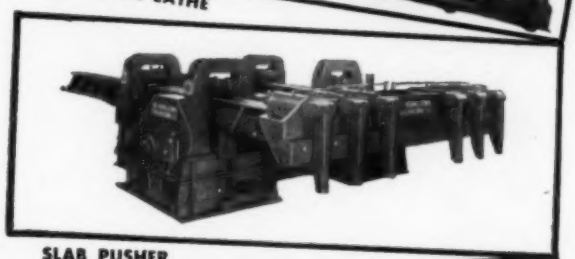


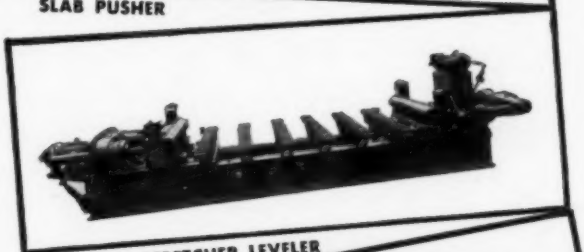
PLATE MILL TABLES

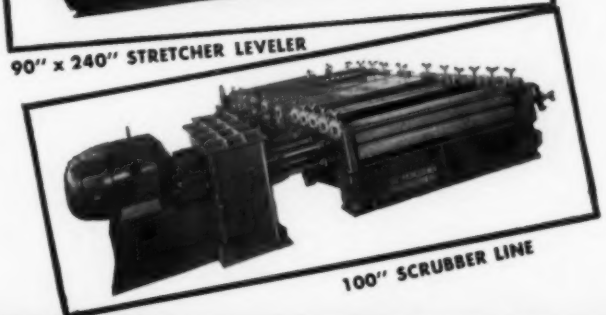
MACHINES, EQUIPMENT, ROLLS AND CASTINGS

PARALLOY ROLLERS


42" ROLL LATHE


SLAB PUSHER


90" x 240" STRETCHER LEVELER


100" SCRUBBER LINE

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- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—Traveling and Lifting Tables
- Continuous PICKLING Lines—ROLLER LEVELERS
- FURNACE Charging Equipment—Furnace Pushers
- Strip Steel COILERS and REELS—SCRAP BALLERS
- RAILROAD Spike Forming Machines—ROLL LATHES
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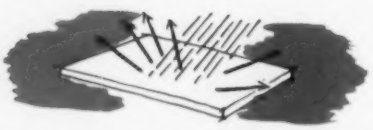
Rust-Oleum finish coatings incorporate the same basic rust-inhibiting vehicle as Rust-Oleum 769 Damp-Proof Red Primer. They provide *double protection* and enable you to *beautify as you protect.*

Practical Answer to Your Rust-Producing Conditions



Rust-Oleum resists rain, snow, heat, fumes, sun, salt water, and chemicals. So easy to use by brush, dip, or spray that one man often does the work of *two.*

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Indoors and out, Rust-Oleum has *proved* its capacity to stop rust! Rust-Oleum can do the same for your tanks, metal sash, stacks, girders, roofs, buildings, machinery, pipes, etc.

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Rust-Oleum is *distinctive* as your fingerprint. It incorporates a specially-processed fish oil vehicle that *dries,* is *odor-free,* and is formulated in *many colors.* Specify Rust-Oleum — accept no substitutes.

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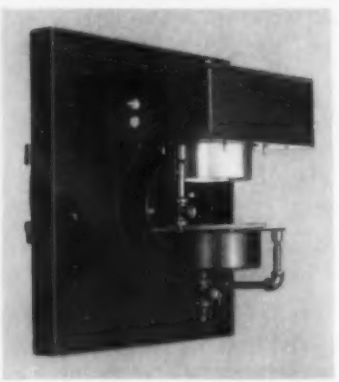
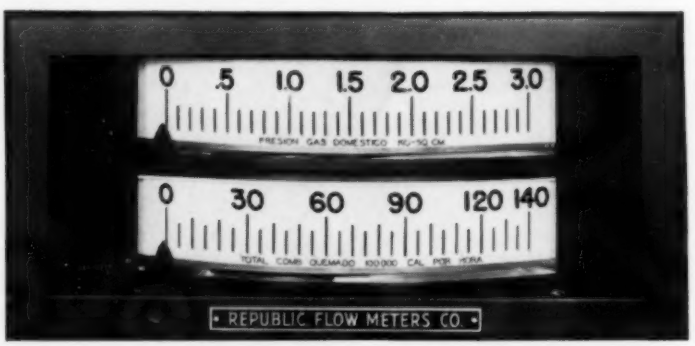
Republic Oil Sealed Bell Recorder at left responds to the slightest changes in furnace pressure and stack draft, and works independently of other controls. Operating principle is so simple that a minimum of maintenance is required. Sealed bell withstands high temperatures and will not crack, rupture or wear out. For pressure or vacuum measurement, the Recorder may be connected directly to a furnace or pipe line. For differentials, it may be connected across an orifice.

Recorder has ranges 0-0.2″ H_2O and 0-8″ H_2O at static pressures to 10 psi. On low range, large 4″ diameter bell gives sensitivity of ±.001″ H_2O.



For quick periodic inspection and cleaning, mineral oil reservoir at rear of Recorder may be lowered by disconnecting one pressure connection and four bolts. Calibration is not changed.



Horizontal Indicator is operated by a tough, resistant diaphragm made of polythylene plastic. Each Indicator is separate and may be individually removed or adjusted. Indicator arm swings on jeweled bearings for friction-free accuracy. Internally illuminated scales may show pressure, draft, pressure-draft combination or differential pressure. Ranges from 0-0.2″ H_2O to 0-40″ H_2O.

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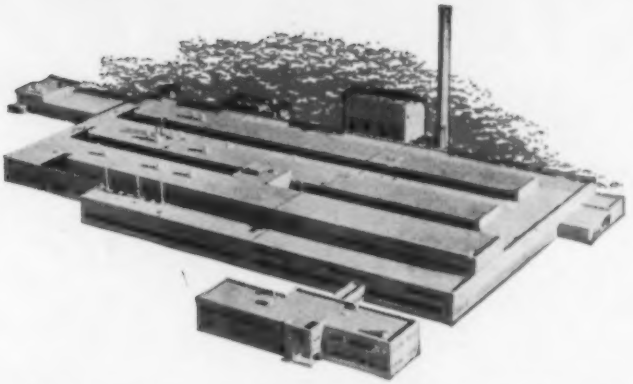
Both instruments fully described in Bulletin 802. Write for your copy today.

REPUBLIC FLOW METERS CO.
2240 Diversey Parkway, Chicago 47, Illinois



N-B-M Meadville . . . where the welcome mat is out. We're proud of this plant—its equipment and the skilled people who work in it. Proud enough, in fact, to offer a standing invitation to Blast Furnace Superintendents or other steel mill officials to visit us. When can *you* make an inspection trip?

These Bosh Plates take it standing up

Here's where you'll find *vertical* molding of copper castings . . . resulting in cleaner metal throughout.

Another reason why N-B-M Meadville is a name to remember when you specify copper castings. During 75 years of foundry experience, you learn many answers to better methods of production . . . methods that *improve casting quality and soundness.*

At N-B-M Meadville, one of these quality-improving production methods is *vertical molding*—eliminating chaplets. We've found—both by test and on-the-job experience—that vertical molding means uniformly higher quality. Any N-B-M Representative will welcome the chance to describe this unique method to you.

From the molding floor to the shipping room, N-B-M Meadville accomplishes what should be, and is, the main objective of this modern, well-manned plant . . . ***what you specify . . . we ship.***

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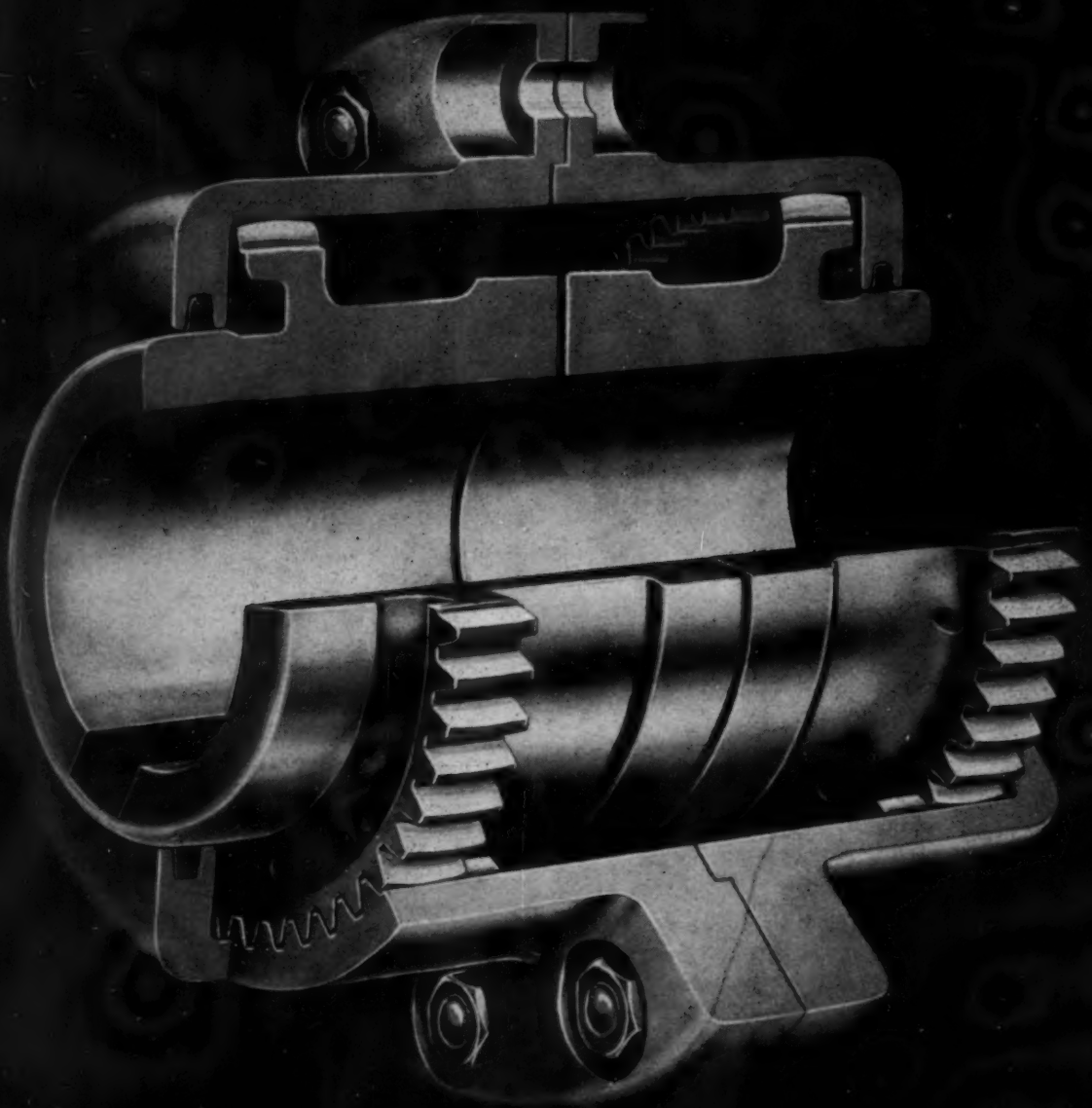


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUES

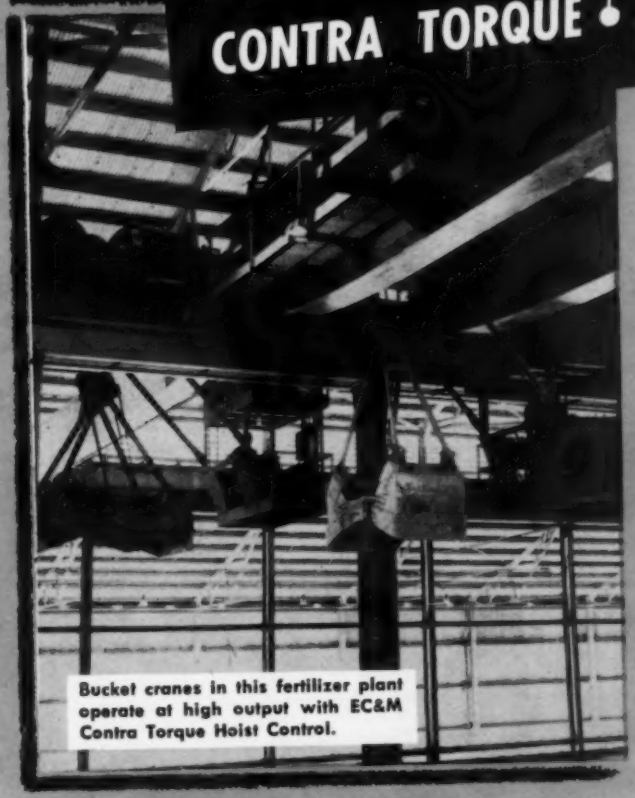
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, M

How EC&M Frequency Relay Control improves A-C Bucket Cranes

Bucket crane of the Level-Luffing type operates speedily under EC&M Contra Torque Hoist Control.



Bucket cranes in this fertilizer plant operate at high output with EC&M Contra Torque Hoist Control.

FAST GETAWAY—Quickly responsive to the frequency of the induced-rotor voltage, EC&M Frequency Relays match torque requirements to the load . . . get the motor up to speed quickly for lowering the bucket —to move the trolley in or out . . . cut down the time between trips.

WIDE SPEED SELECTION—These Relays permit starting-down on any master switch point—no waiting until last point is reached. And a better speed choice gives greater flexibility in clean-up operations, and speeds up output.

SMOOTH STOPPING—When checking motor lowering speed, weak torques are provided for light loads or the empty bucket; stronger torques for heavier loads. Trolley motor is stopped and reversed smoothly under Frequency Relay automatic operation.

SPEED-LIMITING *Safety* on all Speeds. These relays (one set for hoisting and lowering) automatically shift motor connections to safeguard lowering operation with greater skill than human hands could do it.

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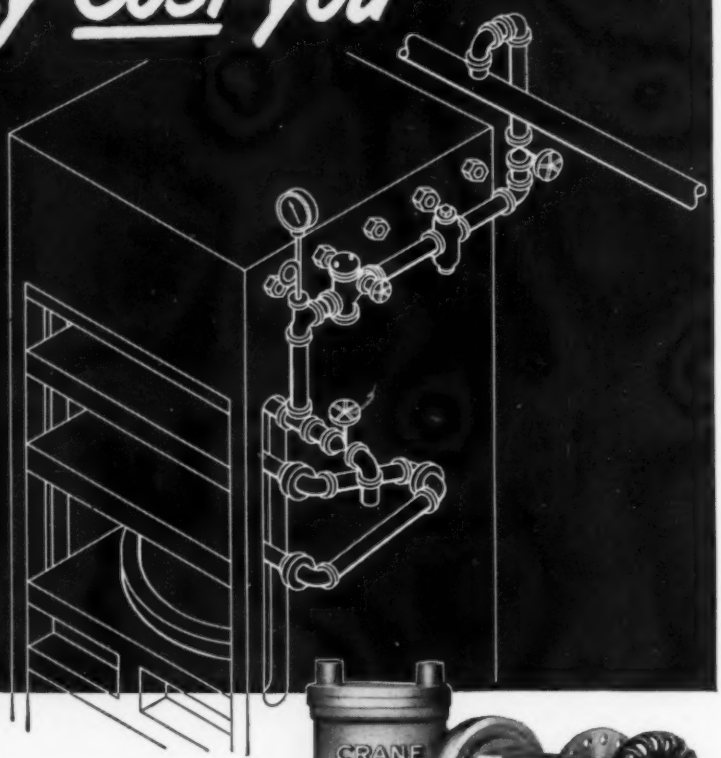
on Steam Heated Machinery

for example

(A Case History)



Crane No. 960 Brass Pressure Regulator, for steam or air, up to 250 psi. See your Crane Catalog.

What you pay for valves is not the final criterion of value. Not when maintenance can quickly equal or exceed purchase price. A thrifty buyer knows his maintenance; knows also there's bigger value in better quality.

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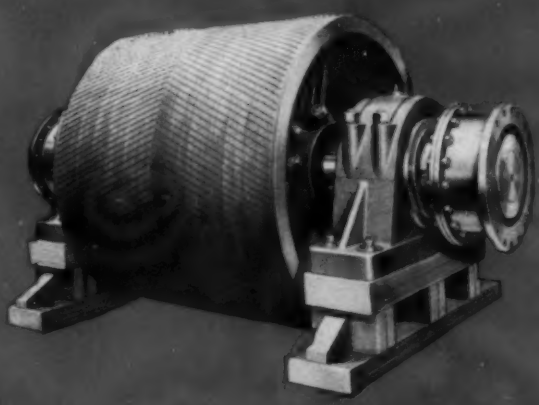
- Drive Pulleys with plain or grooved lagging.

End view of Jones 60" x 64" Pulley showing heavily ribbed arms and split-clamp hub.



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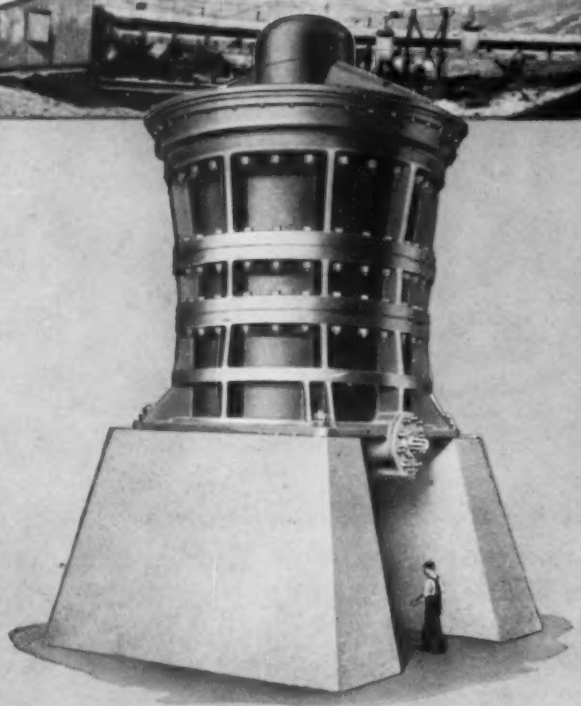

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As Mesabi Ores Lean Out, Allis-Chalmers Aids in Beneficiation

DIRECT SHIPPING ORES are fading fast up on the once fabulous Mesabi range. But despite foreign ore discoveries, by 1955 a quarter of blast furnace feed must be beneficiated domestic ore.

Allis-Chalmers — manufacturer of equipment for the steel industry from the mine to the mill — is helping lead the way to more economical beneficiation of lean ores.

Does low ore content require you to triple material handled? Allis-Chalmers will build you bigger, more efficient equipment! At far left below is the world's largest crusher, being built by A-C for a Mesabi taconite plant.

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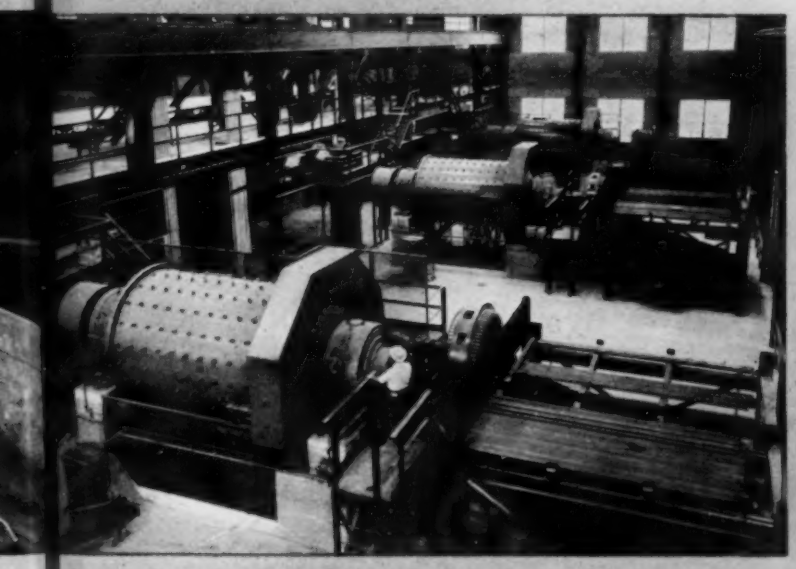
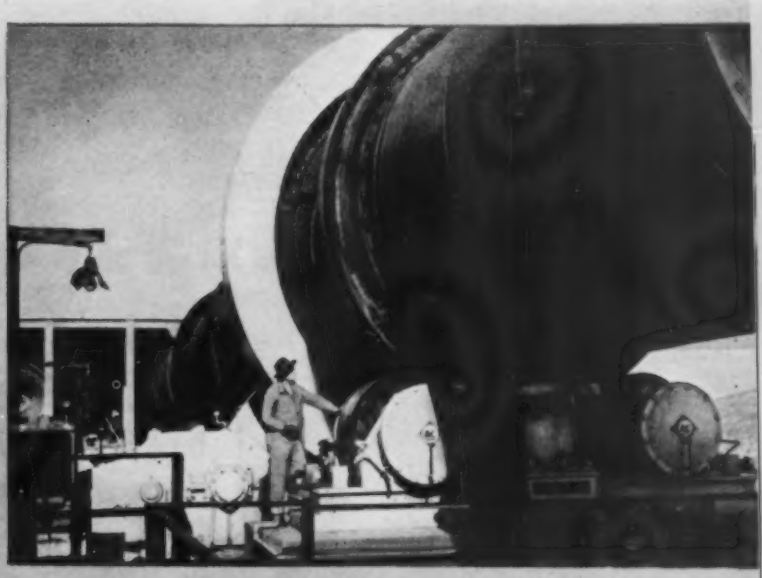
For over half a century Allis-Chalmers equipment has been processing ores for America's steel industry. Some of the cost-cutting, tonnage-increasing ore beneficiation equipment in the broad A-C line is seen on these pages.

Allis-Chalmers offers you *one-manufacturer responsibility* for process, drive and control equipment all along your flow sheet. For literature or detailed information on products and services, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3808

Superior, Ballpeb and Texrope are Allis-Chalmers trademarks.



ORE IS GROUND in three rod and ball mills ahead of magnetic separation at this beneficiation plant. A-C builds *all* types of grinding mills for ore beneficiation processes.



IRON ORE IS AGGLOMERATED to make good blast furnace and open hearth feed in Allis-Chalmers rotary kilns in connection with iron mines and beneficiation plants.

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Crops and Shorts

THERE have been many indications that the business men holding important posts in the new administration in Washington were shocked by the inefficiency and extravagance they found, and intend to do something about it — and that's cheering news. It is to be hoped that these good intentions do not get bogged down in politics, but the recent decision of Secretary of Agriculture Benson to continue the support of the price of butter at 90 per cent parity has disappointed a lot of people.

The federal government is buying almost half of the butter produced, and is thus holding up the price to a level that drives people to buy margarine at about 35 per cent of the butter price. So butter consumption has dropped 50 per cent in the past 12 years, and is still dropping. Apparently consumers cannot afford to support the dairy industry with taxes and buy high priced butter at the same time. If the price of butter were allowed to drop somewhat, maybe consumers would switch back to their old eating habits.

Maybe, if the buggy builders could have held out till now, they could continue in business — and we wonder what would happen if plastics, aluminum, etc. took over half of the steel usage. At least steel would not get rancid in storage.

▲

THERE was a time when the phrase "looking for work" implied just that. Recently, when 529 college students were questioned about careers, 29 per cent favored the retailing business. But the figure fell to 26 per cent if Saturday work was required, and to 25 per cent if there was to be evening work.

▲

A F. Franz, president of Colorado Fuel & Iron Corp., said "I do not expect a depression or a recession in 1953 and I expect the current high rate of production to continue for the rest of the year."

▲

IT'S getting so that a man who has not been investigated by the government is pretty much a nonentity. If a man ever wants to work for the federal government, he should avoid bad companions and good investments. However, General Motors does not insist that a man sell his government bonds before they hire him.

MARCH 15th leaves us convinced that we should all be classed as government workers, but without vacations, sick leave or holidays. This generation was brought up on the wrong side of the tax.

▲

SPEAKING before the New York Society of Security Analysts, Avery C. Adams, president of Pittsburgh Steel Co., warned against placing too much emphasis on the determination of break-even points in the steel industry.

"When the going is tough," he said, "we have found ways and means to cut our costs."

▲

FIGURES released by the American Iron and Steel Institute show capacities of the various steel producing districts as follows:

	Net tons per year
Eastern	23,864,000
Pittsburgh-Youngstown	43,621,000
Cleveland-Detroit	12,003,000
Chicago	24,960,000
Southern	6,036,000
Western	7,063,000

▲

THE iron and steel industry paid out $1,074,770,000 in taxes in 1951, second in amount only to the automotive industry. This was about 13 per cent of the industry's sales for that year.

▲

TOTAL employment of the iron and steel institute hit a record of 684,400 at year-end, with the pay rate averaging $2.21 per hour.

▲

A recent release from the Government of India information services tells about Narain Singh, a healthy 176-year old man who expects to live at least 25 years more. Mr. Singh, who lost his regular teeth just before turning the century mark, has grown a complete new set and his gray hair is turning black again.

Just goes to show what can happen if you stick to a thing long enough.

▲

ACCORDING to the American Iron and Steel Institute, there are now 143 steel producing plants in the United States as compared to 128 in 1939. The principal new plants are in California, Texas, Washington, Utah, Oregon, Tennessee and Pennsylvania.

▲

MAYBE the reason a dollar doesn't do as much for us now as it used to is that we don't do as much for a dollar as we used to.

▲

FURNACE door castings of ductile iron have been found to last 40 times as long as gray iron castings.

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PORTABLE BASE
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Basic design permits Single-Stack Portable Base furnaces to do a job of annealing unsurpassed by any other method. The surfaces of coils in larger multiple-stack furnaces are necessarily at varying distances from the heat source. Tube radiation is limited to but two sides of the charge whether the tubes are along the walls or across the furnace between the coils. (See Figures 1 and 2.)
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LEE WILSON has developed the first truly portable base system that works. This has put an entirely new outlook on annealing quality, times and cost. With this system, expensive pits and base supporting structures are eliminated. Uniformity of metal structure never before accomplished is obtained—at speeds that make obsolete most existing equipment. And maintenance and operating costs are reduced.
During the past year, we told the story in monthly installments that created an active interest throughout the steel industry.
Now here's the whole story, neatly packaged for your files. So if steel strip coil annealing is a part of your operations, you'll want to have all of this information about the Lee Wilson Portable Base Single Stack Annealing System.
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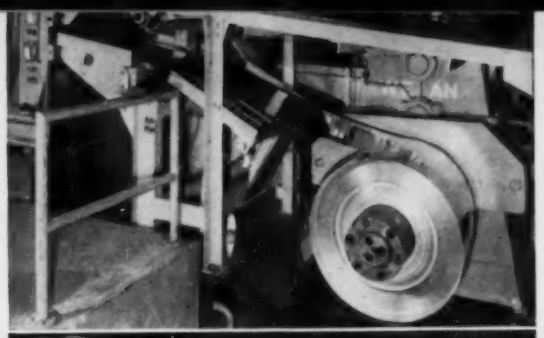

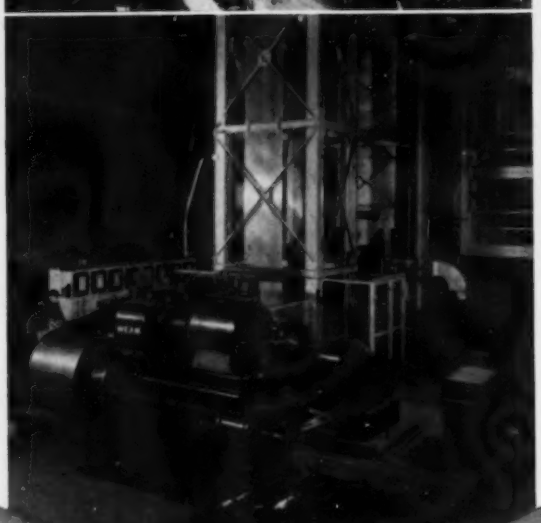

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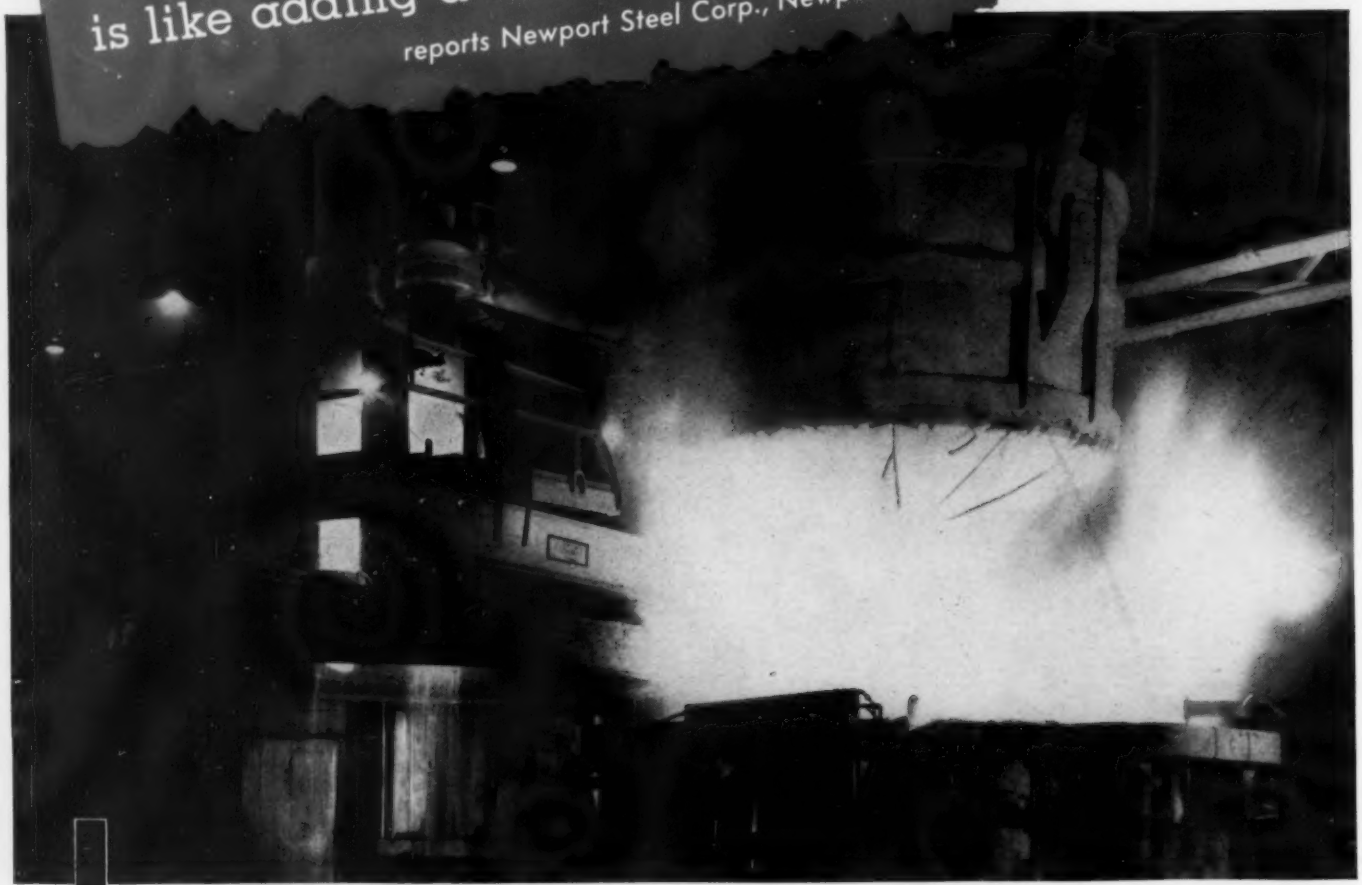
"Top charging on our two electric furnaces is like adding a third furnace!"

reports Newport Steel Corp., Newport, Ky.



Lectromelt* fast-opening furnace top in its charging position.

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MOORE RAPID

WHEN YOU MELT... *Lectromelt*

INCREASING PRODUCTIVITY OF FONTANA BLOOMING MILL

By WILLIAM A. VOGT
Project Engineer
Kaiser Engineers, Inc.
Oakland, Calif.

. . . . designed primarily for war production, ingenious adaption and modification of the original equipment has enabled an increase in production from 500,000 to 1,200,000 tons annually . . . .

▲ AT the time that ground was broken at Fontana for the Kaiser steel plant, early in 1942, the United States had joined in the war against Japan and Germany and, building up its industrial strength, needed most of all ships for the transfer of war material. Fontana was to produce the plates needed to supply the shipyards on the West Coast. Thus, war needs helped the Fontana steel plant into being, and realized one of H. J. Kaiser's ideas for the industrial development of the West.

Building a war plant with government help had its advantages but it also had serious disadvantages in form of restrictions, and it is well known that many a war plant either came to an end almost at the same day the war ended, or more often, was never able to establish competitive operation during peacetime because of the impossibility to convert the plant. The restrictions under which the Fontana plant had to be built were of the most severe type, and only a great deal of foresight and care in the original planning made a successful conversion from wartime to peacetime operation possible.

The W.P.B., considering Fontana strictly as a "war baby" with hardly any prospects to survive the end of the war, confined the original authorization strictly to the bare facilities for the production of iron and steel and the rolling of ship plates. To this authorization was attached the condition that the Fontana plant should be set up for an operation method requiring the absolute minimum of heavy equipment, and the further restriction that whatever heavy equipment had to be bought, should not be ordered from well-known manufacturers of such equipment in order not to interfere with the execution of equipment orders for other plants.

These restrictions on heavy equipment led to the adoption of the direct rolling process of plates, and in consequence, to bottom pouring of ingots in the open hearth for the original layout of Fontana.

A short time after this original authorization was granted by the W.P.B., an additional authorization for a structural and merchant mill was given to round out the Fontana rolling mill layout.

Having explained the factors which determined the first Fontana layout, we shall now describe more in detail this first Fontana rolling mill installation and also the methods used in the production process in order to be able to appreciate the alterations and additional facilities necessary for the conversion of the original installation from wartime to peacetime production. As we shall see, this conversion was achieved not only successfully and by very economical means, but also was the basis for an increase in rolled products from 500,000 tons a year to 1,200,000 tons a year.

The original Fontana plant as authorized by the W.P.B., consisted of one 1200-ton blast furnace, four 185-ton open hearth furnaces and the plate mill, with the structural mill and merchant mill added at a slightly later date. The plate mill consists of a 42 x 110 in., 2-high reversing stand, followed by a 3-high finishing stand with 40 x 112 in. top and bottom rolls, and a 26-½ in. diameter working roll.

The 2-high reversing mill has twin motor drives of 3500-hp each and is preceded by a 44-in. vertical edger driven by a 1500-hp motor. The 3-high stand is driven by a 7000-hp motor.

Besides these two mill stands, the plate mill installation is made up of the usual mill tables, levelers, cooling and transfer beds, straighteners, edge trimmers, shears and other finishing equipment.

The rolling range of the plate mill covered a minimum thickness of $\frac{3}{16}$ in. and a maximum plate width of 96 in. Shearing facilities for plates were limited to 1-in. plate thickness. The rate of production for the original mill setup was approximately 1000 tons per day.

The structural mill as added to the rolling mill layout by the second authorization of the W.P.B., consisted of a 36-in. 2-high reversing mill, and three stands of 29-in. structural mill. Two stands were 3-high, the finishing stand 2-high.

As it is readily apparent from the original Fontana plant layout, this 36-in. mill was planned to work ultimately as a break-down mill in connection with a blooming mill, for which space had been reserved in the layout between the 36-in. mill and the soaking pits, but this blooming mill has never been installed, and the 36-in. mill of the original layout had to perform the duties of the blooming mill and the break-down mill. For this reason, two reheating furnaces were provided for the structural mill, one furnace ahead of the 36-in. mill and one furnace between the 36-in. mill and the structural mill. These furnaces enabled the 36-in. mill

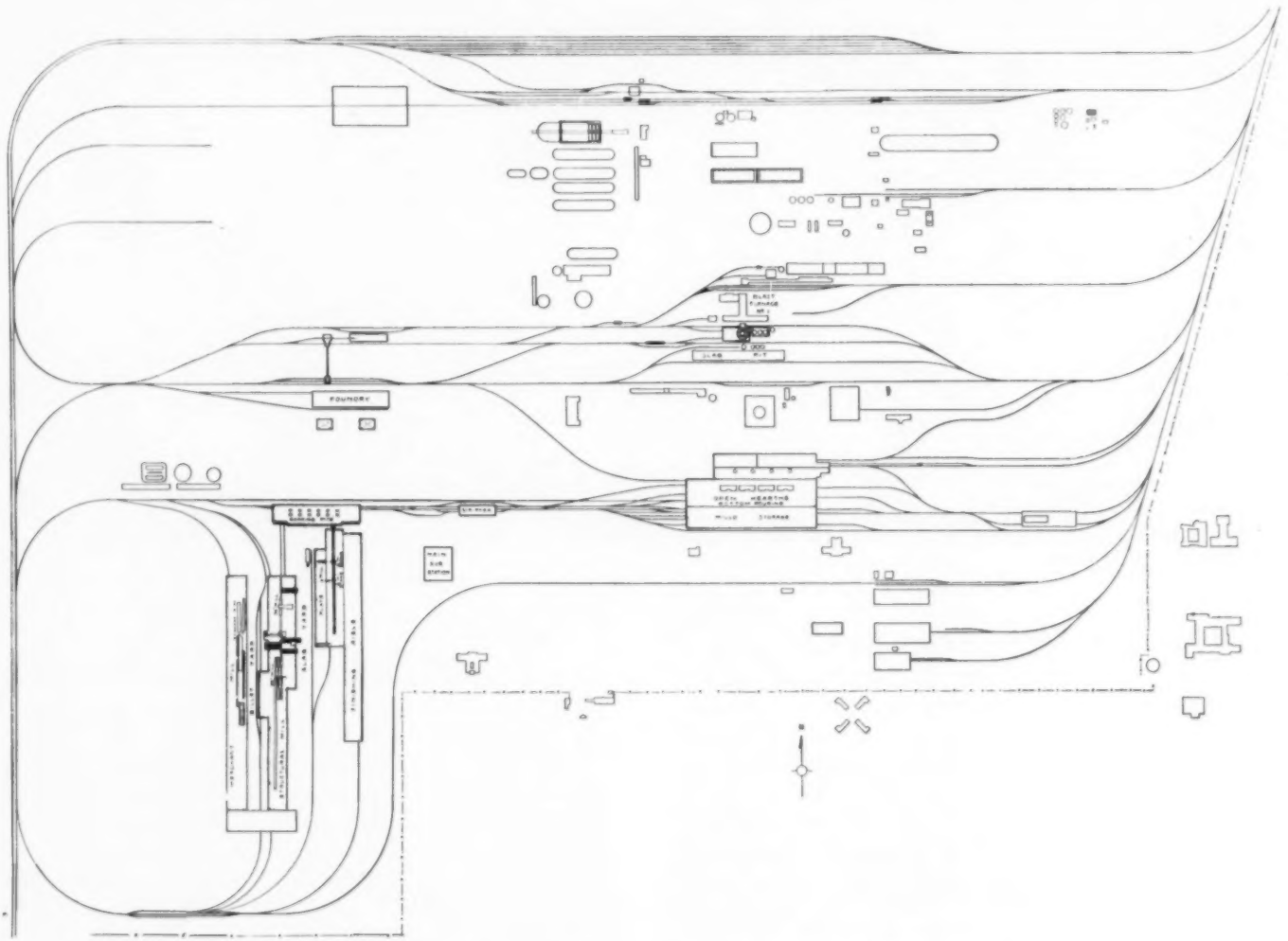

Figure 1 — Original layout of Fontana Steel plant was designed for direct rolling of plates from slab ingots. Plant production was scheduled at 500,000 tons per year.

to roll ingots first to blooms, and after the reheating of blooms, to work as a break-down mill in connection with the 29-in. structural mill.

Both mills, the plate mill as well as the structural mill, were supplied with ingots by a battery of twelve pit furnaces, the axis of which was running at 90 degrees to the axis of the rolling mills. An ingot buggy running alongside the soaking pits discharged slab ingots at one end of its run into the plate mill entrance tables, and at the other end of its run, onto an ingot transfer buggy which overbridged the gap left open for a future blooming mill between soaking pits and 36-in. mill.

The original Fontana rolling mill layout is shown on Figure 1. We shall see that the original layout as such is on a very modest scale compared with gigantic plants being built today, but in the last ten years the picture of the Fontana plant has greatly changed. The empty spaces of the first layout have been filled in by additional facilities which gradually developed into the harmonious layout, the Fontana rolling mill installation and the Fontana plant in general represent today.

Having described the physical layout of the original Fontana plant, we have to discuss the operational methods which were used in connection with this layout and the results achieved with layout and methods.

As mentioned above, government restrictions made it necessary to adopt direct rolling of plates from ingots at Fontana. Direct rolling, in turn, requires bottom pouring of ingots in the open hearth.

The method of bottom pouring is still widely used and produces ingots of improved surface as compared with top poured ingots. It also lends itself well for pouring of small ingots, which is important in the direct rolling process, as in this process the ingot height is determined by the size of the plate to be rolled from this ingot. The economics of bottom pouring, however, can be favorable only if certain conditions are existing; otherwise this process will be extremely expensive on account of additional labor involved, the additional refractories needed for fountains and runners, and on account of yield loss due to runner scrap.

In Europe, where the bottom pouring method is standard and where it is used not only for plate ingots but also for structural ingots, the soaking pits usually are immediately adjacent to the open hearth teeming aisle, and the whole layout aims at the very shortest distance between pouring pits and soaking pits. The ingots which are poured in stationary pits, are stripped in place and immediately transferred by means of a transfer buggy through the column row to the adjacent soaking pit building. The heat losses caused by such a short transfer are of course very small.

At Fontana such a favorable ingot transfer condition, which alone can make bottom pouring advantageous, did not exist and could not exist if the plant was to be converted to indirect rolling of plates after the war.

In the Fontana open hearth, bottom pouring was not done in stationary pits but on ingot cars using sprue plates and fountains, which had the great disadvantage that the sprues which are hanging to the bottom of the ingots could not be twisted off in the sprue plates the way this is done in stationary pits. On account of the diversified length of plates and the resulting necessity to tailor each ingot to the size of the plate to be rolled, the number of ingots and ingot cars was extremely large. This resulted in excessive work for the stripper and a long track time, which means great heat losses. For all these reasons, the ingots reached the soaking pits in a cooled off condition and tended to overtax the soaking pits, which resulted in down time for the mill, as it is generally known that soaking pit production depends on the temperature and the weight of the ingots charged, the same way as rolling mill production hinges on the degree to which these ingots are heated in the pits.

On account of all these difficulties it is easy to guess that the economics of the direct rolling process of plates were not too good, and it was clear that although this method could give the required results during the war, it could never be sufficiently profitable under peacetime competition. Consequently, it was only natural that when the war came to an end in 1945, immediate efforts were made to free the Fontana rolling mill operation from the uneconomical wartime restrictions by abandoning bottom pouring and direct rolling, and introducing instead, slabbing of ingots and rolling of plates from slabs. Extensive studies had been made on this subject, and in the spring of 1946 the proposed alteration and certain plant additions for the rolling of plates at Fontana were authorized.

This would have been the opportune time for the installation of a big 42 or 44-in. blooming mill in the empty space between soaking pits and 36-in. mill. However, as business conditions right at the end of World War II were not too stable, it was decided to do without a new blooming mill and to do the slabbing of ingots on the existing 36-in. mill, after certain alterations.

We have to remember that the 36-in. mill was built as a break-down mill only, and although it had stood up very well up to that time in rolling structural mill ingots, it never could be expected to handle plate ingots of more than 10 tons and the additional burden of the plate tonnage. Therefore, a conversion schedule had been set up to include the following alterations:

1. General strengthening of the 36-in. mill housing to handle the much heavier slab ingots, at the same time increasing the lift of the 36-in. mill to allow for rolling of 36-in. wide slabs.
2. Alterations to improve the delivery of ingots to the mill and to speed up the removal of slabs from the mill by rebuilding the ingot transfer car between soaking pits and 36-in. mill, and by adding a slab piler at the end of the slab transfer bed behind the shear.
3. Installation of a slab yard with facilities for surface conditioning of slabs.
4. Installation of a slab heating furnace with slab depiler, charging and discharging equipment.

The extent of the alterations, and especially the modification of the 36-in. mill to handle the greatly increased load of heavy ingots will be described in the following section, and it will be shown by what means it was possible to effect the conversion almost immediately without losing months of time waiting for a new blooming mill. This proved of special importance,

as at that time long strikes in industry and railroads, and even harbor strikes, delayed the functioning of the industrial life in the United States greatly.

36-IN. MILL ALTERATIONS

The 36-in. mill, as originally installed at Fontana, is a 2-high reversing mill driven by a 5000-hp motor, 50 to 120 rpm, 700 volt. The pinions are 36-in. in diameter and are connected to the mill rolls by universal spindles.

The mill rolls are 37-½ in. maximum for bloom shapes and 34 in. on slab rolls. The body length of the rolls is 82 in. The roll necks are 22 in. in diameter and are running in composition bearings, water lubricated.

The maximum roll lift of the original housing allowed the rolling of slabs with a maximum width of 28 in.

The original mill housing was of open top design. The mill tables and manipulators were of fairly heavy construction and, although not of the latest design, had been working quite satisfactorily. However, as previously pointed out, certain alterations became imperative at the moment the decision was made that the 36-in. mill would take the additional load of slabbing the plate mill ingots in addition to the structural ingots.

Under the uncertain economical conditions existing right after the second World War, it was felt wise to keep the investment in the proposed mill alterations to a minimum, and thorough investigations were made to determine what could be achieved, making use as much as possible of the existing equipment.

The most conservative, and of course the most expensive way, to buy all new equipment, was unacceptable as it would have involved not only many months of waiting for the new equipment but also, due to necessary changes in foundations, would have caused long delays and production losses on account of the time needed for the installation of the new equipment. Fontana needed the conversion without loss of time, and for all these reasons this scheme could not be accepted.

The other extreme, involving the least expenditure and time losses, would have been to convert the existing equipment only. This possibility was given careful study and would have been entirely feasible except for the request that the new slab width was to be 36 in. The roll lift of the existing housing was only sufficient to allow 28-in. wide slabs to be rolled from 26 x 34-in. ingots. For this reason, this scheme had to be discarded also.

Considering all factors, the engineers and operators at Fontana agreed on a compromise between the two schemes. It can be stated in advance that their decision was a very fortunate one as it gave the operators sufficiently heavy mill equipment for the greatly increased production, and on the other hand, saved considerable installation costs by accepting the responsibility for a somewhat unusual installation.

The final scope of the work provided:

1. Installation of a new mill stand of closed design permitting a 38-½ in. lift of the top roll and having an increased cross-section of posts. The new stand was to fit on the existing mill shoes, requiring only very slight foundation changes to accommodate new steel-yard rods, the linkage to the rod carrier, and the hook end of the counterweight arm.
2. Use of the existing pinions, spindles and spindle carriers, and compensating for the higher lift of the new top rolls by inserting 9-in. fillers between pinion housing and shoe plates, and also between drive motor and motor bed plates. The raising of the pinions by 9 in. left the angularity of the top spindle unchanged from formerly existing conditions, however, placed a fixed angularity of approximately 3 degrees on the bottom spindle (top spindle 9 degrees-50 minutes, bottom 2 degrees-45 minutes). It was this raising of pinions which created much discussion and controversy, as it was predicted by certain parties that the wear of the liners of the bottom spindle would be excessive. It may be stated at this time that after more than five years of operation with raised pinions, Fontana has not experienced any detrimental results from the angularity of the bottom spindle.
3. Besides the above major points of the conversion, the following equipment changes were included:

   A new mill screwdown was to be installed with a special coupling in the cross shaft to permit accurate leveling of the mill.

   New manipulator side guards, with longer finger stroke necessary for the turning of wide slab ingots, were provided for entry and delivery table.

   The feed rollers on each side of the mill were to be equipped with individual drives and built in removable units that would fit into slots of the mill housing, which would allow replacement by rest bars when rolling structural shapes.

Figure 2 shows the mill stands and pinion housings before and after the alteration, and indicates that no change has been made in the equipment location except for the liners inserted under pinion housing and motor.

Comparing the two arrangements shown on Figure 2 in regard to the increase of the roll lift, we notice that the original rolls are shown as 34 in. in diameter, with a maximum working center of 5 ft-4 in. These original rolls did not have collars.

Deducting one roll diameter of 34 in. from the maximum working centers of 5 ft-4 in. gives an opening between the rolls of only 30 in. The size of ingots originally used for slabs was 26 x 34 in., which measured approximately 32 in. at the small end of the ingot. This shows how difficult it was to roll slabs from this size ingots on the original arrangement of the mill.

Considering now the modified arrangement of the mill, we see that the maximum diameter of the rolls is given at 33 plus 1-½ in. deep collars for new rolls. The minimum diameter of the rolls used in this mill will be 28 in.

The distance between the center line of the bottom roll and the center line of the top roll when in its highest working position is shown in the modified arrangement of the mill as 5 ft 10-½ in., and is correct for the use of minimum diameter of rolls. When new rolls, which are 33 in. in diameter, are used in the mill, liners are taken out from underneath the bottom bearings in order to keep the top elevation of the bottom roll the same. Consequently, the 5 ft 10-½ in. dimension for the work-

ing center increases by 2-½ in. (one-half of the difference between 33 and 28 in.) to compensate for the increase in the diameter of the rolls. This 5 ft 10-½ in. dimension then becomes 6 ft-1 in. Deducting the diameter of one roll of 33 in. from 6 ft-1 in. provides an opening of 40 in. between the faces of the top and bottom rolls. The size of the new slab ingot is 30 x 42 in., with 40 in. at the small end of the ingot. These slab ingots consequently enter the mill without difficulties.

Besides the changes to the mill and the mill equipment which were done during the main conversion period of the mill, we have to mention two important changes which were made at a later date, a year or two ago, and which contributed considerably to the increase in production by decreasing down time. These changes include alterations to the flume system for the scale removal from the 36 in. mill and the installation of voltage regulators for the main mill motor.

The changes to the scale flume system consisted of the separation of the scale flumes into three individual parts, a separate flume for each of the two mill tables, and an individual flume for the mill stand proper. All flumes were equipped with adjacent walkways and have full head room to facilitate inspection, cleaning and maintenance. A powerful recirculating system for scale flushing was provided for each flume.

The results of the alteration of the scale flumes were most gratifying, as many mill delays, previously caused by accumulation of heavy scale and ingot butts, were almost completely eliminated.

The other important change which took place as recently as 1950, was the replacement of the original excitation for the 5000-hp motor driving the 36 in. mill with new exciters and roto-control generators.

The installation of this roto-control equipment made it possible to reverse the mill from base speed in one direction to base speed in the other direction in 1.4 seconds. Actually, the reversing speed now used at Fontana has been set at 2 seconds, due to the operators' preference and the mechanical limitations of the other mill equipment, for instance mill tables. With the installation of the new excitation equipment, many relays and contactors of the control equipment were eliminated, which in turn reduced the maintenance problem and down time.

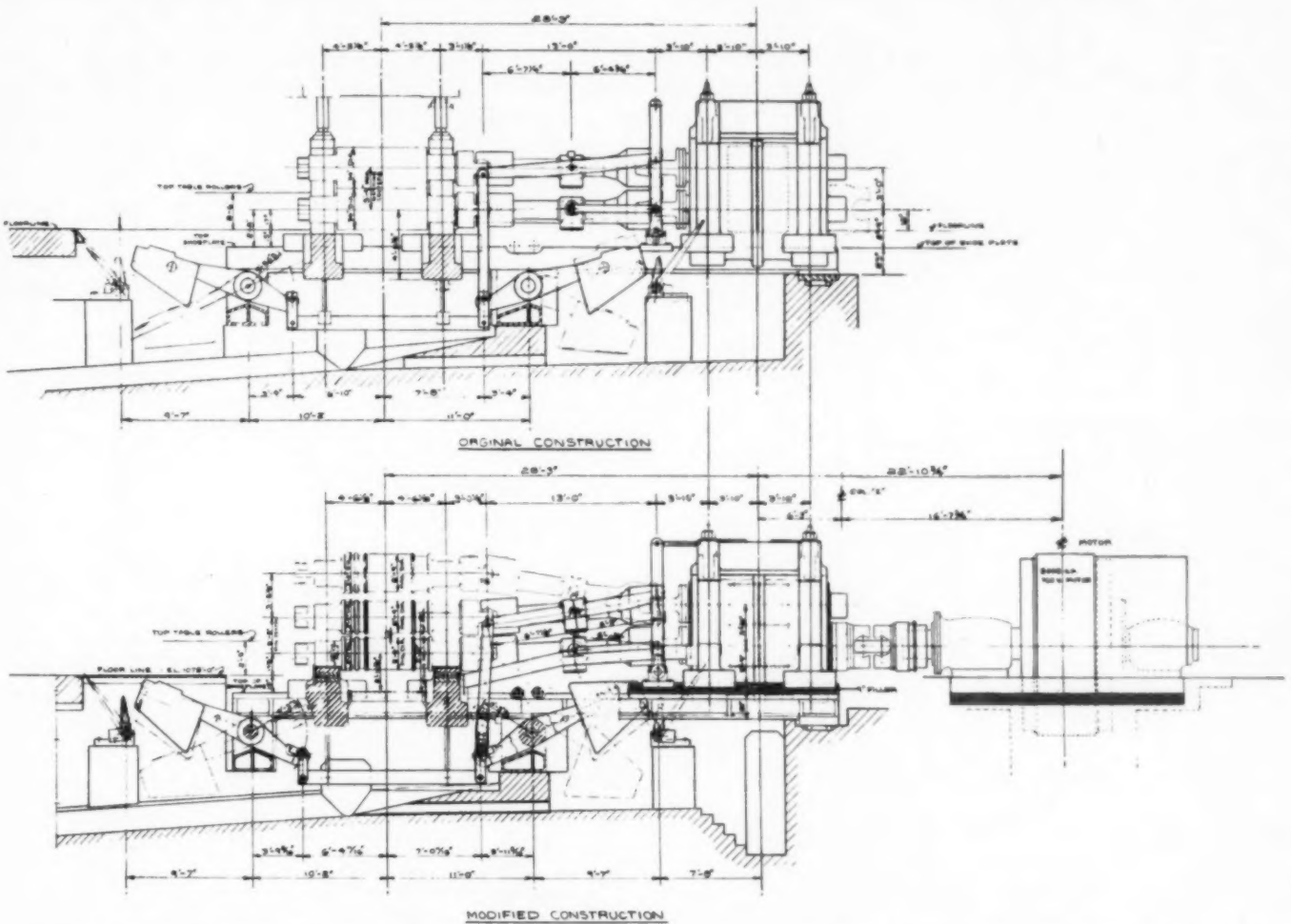

Figure 2 — Upper sketch shows original construction of 36-in. blooming mill and bottom sketch shows modified design.

MODIFICATION OF EXISTING EQUIPMENT

Up to now we have been dealing with the modification of the 36 in. mill proper, but in order to get the increased production, for which we have prepared the 36-in. mill by the above-described alterations, to the mill and away from the mill, the rest of the mill instal-

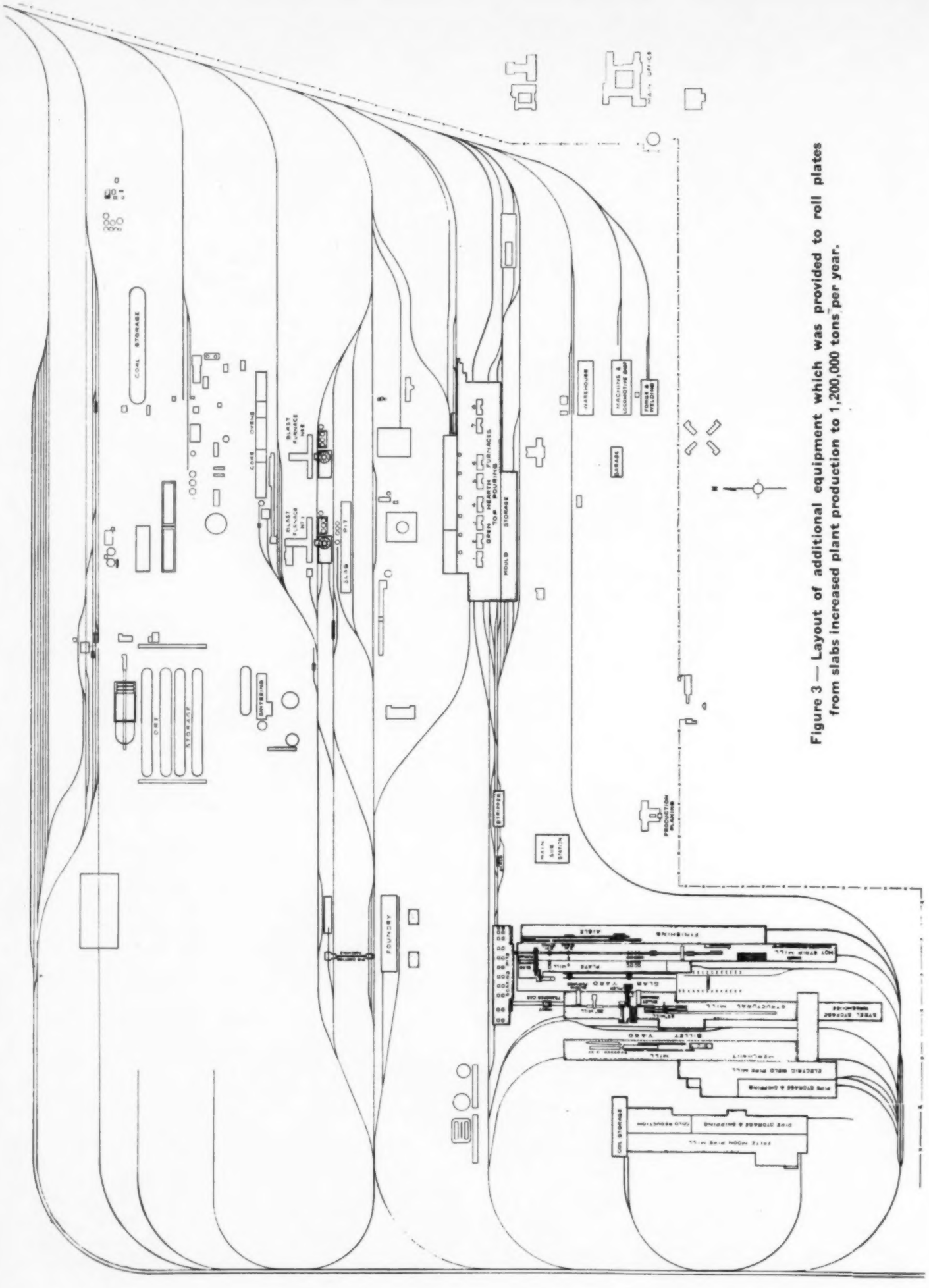

Figure 3 — Layout of additional equipment which was provided to roll plates from slabs increased plant production to 1,200,000 tons per year.

lation before and after the 36-in. mill had to be modified also. This equipment included mainly the ingot transfer car between soaking pits and 36-in. mill, and the slab transfer and slab piler after the mill.

The redesigning of the ingot transfer buggy presented complex engineering problems as it was to solve all of the following requests: increased speed, adequate provisions for removal of scale falling off the ingots during transfer, and a crossing of the ingot buggy track and the transfer buggy track at the soaking pits.

This latter request for a track crossing meant raising of the transfer buggy track by 2 ft. This could be achieved only by decreasing the overall height of the buggy by 2 ft, as the top of the buggy had to stay at the same elevation in order to line up with the elevation of the mill entry table.

As it happened, the decrease in height of the buggy, difficult as it appeared in the beginning, has proved to be a full success, which, at the same time, brought about the solutions for the other requests. The raising of the tracks took care of the scale problem, and the cutting down of the buggy height decreased the dead weight and increased the obtainable speed. The decrease in buggy height was achieved by replacing the rigid drives connecting to both axles by means of heavy gear reduction boxes, by a single traction motor connected to one of the axles only.

In order to speed up the flow of the increased production from the mill to the slab yard, a piler was installed at the end of the 20-ft wide transfer table. The piler was designed to handle blooms as well as slabs. To allow uninterrupted operation of the transfer table, the piler was designed as a double piler with two sections, each section independent of the other mechanically and electrically.

The two elevators, when operating separately, can pile slabs from 24 to 36 in. wide by 100 in. long in piles 36 in. in height. When operating as a single unit, the piler can pile blooms and beam blanks 20 ft long.

As an additional safety factor, the arrangement of the piler skids and the racks of the transfer table was such that the overhead crane could take the slabs and blooms off the transfer table by means of a "C" hook in case of necessity.

ADDITIONAL FACILITIES

In order to complete the description of the changes leading to the increased production of the Fontana rolling mill, we still have to describe briefly the additional facilities involved in the conditioning and reheating of slabs for the re-rolling of the plate mill.

For slab storage and slab conditioning, the existing east billet yard was extended northward by 250 ft. Some changes to the overhead cranes were made, and two 7-½-ton stiff-leg gantry cranes were added. These cranes, with a span of 25 ft and equipped with duplex magnets, were installed to operate along the east side of the billet yard to facilitate the handling of slabs and blooms during the surface conditioning. Generally the section of the billet yard north of the piler was used for slabs, and the section south of the piler for blooms.

For the reheating of slabs prior to the re-rolling on the plate mill, a continuous slab heating furnace was installed north of the plate mill motor room, which allows for the discharge of slabs onto the 2-high mill approach table in the plate mill.

The slab heating furnace has a width between walls of 20 ft and a hearth length of 70 ft. It has a rated heating capacity of 70 tons per hour from cold to 2250 F, based on slabs 8 x 36 x 100 in. long.

The furnace charging equipment consists of a screw-type elevating depiler with magazine for holding slab piles up to 36 in. high, and complete with depiler pusher. The depiler discharges over a reciprocating transfer table to a roller table, which is used for spotting of the slabs in front of the furnace skids. A 100-ton double slab pusher, operating singly or doubly, charges and discharges the slabs. This slab pusher has a maximum stroke of 8 ft.

At the discharge end of the reheating furnace, a double bumper, consisting of two units spaced at 9-ft centers, has been provided to stop the slabs when discharged from the furnace. These bumpers, which are of special design, protect the furnace discharge table by absorbing the impact of the slabs.

The complete layout for the conversion of the rolling program, from direct rolling to rolling of plates from slabs, is shown on Figure 3. Comparing this sketch with Figure 1, we see how the new equipment and facilities fitted into the empty spaces provided for in the original planning.

	JANUARY THRU MARCH 1944	OCTOBER THRU NOVEMBER 1951
NUMBER OF PITS	12	18
AVERAGE TONS INGOTS / HR.	64	172
TRACK TIME* - HRS.	4	2
INGOT WEIGHT - LBS	6,300	17,000
% COLD CHARGE - %	16	0.2

* FINISH POUR TO CHARGE IN PITS.

Figure 4 — Tabulation shows comparison of operating results for the soaking pits for 1944 and 1951.

DATA ON INCREASED PRODUCTION

On Figure 4 we have tabulated the increased production which Fontana has achieved by the changes in equipment and production methods discussed above. This sketch compares the mill production during a three months' period in 1944 under bottom pouring and direct plate rolling conditions, with a corresponding three months' period in 1951 under slab rolling conditions.

According to this tabulation, the average ingot weight was increased from 6300 to 17,000 lb. (The maximum slab ingot weight is now around 23,900 lb). The track time, that is, the time from finished pour to charging of ingots in the pits, was decreased in this period from four hours to two hours. The decrease in track time is the result of the increased ingot weight and the smaller number of ingots, and in turn, resulted in a reduction of cold charge from 16 to 0.2 per cent.

The heavier ingots and the higher charging temperature resulted in an overall increase in the average tons per hour of heated steel from the soaking pits, from 64

tons per hour to 172 tons per hour. This figure, however, has to be qualified on account of the increase in number of pits from 12 in 1944 to 18 in 1951, as indicated on our tabulation.

These figures represent the improvements gained from mill alterations and from the change in rolling mill practices, and certainly justify the effort as well as the investment. Of course, looking at this chart we must not forget that these remarkable improvements have been materially aided through the great efforts of the mill crews, further encouraged by the introduction of an incentive bonus plan.

CONSTRUCTION RECORD

This report would not be complete without having discussed briefly the time required for the alterations and modifications. For this purpose we have prepared the construction schedule shown on Figure 5. This construction schedule indicates that the conversion from direct rolling to plate rolling from slabs was not achieved during one long shutdown period, but rather

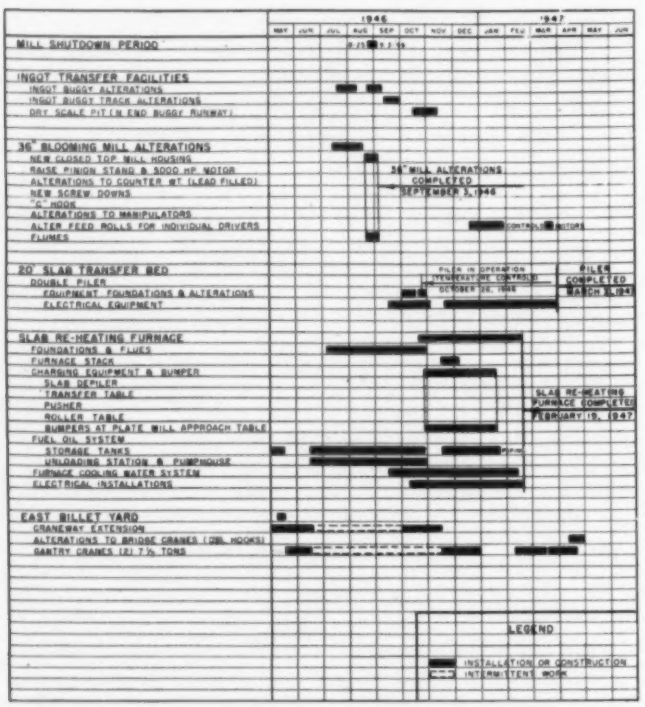

Figure 5 — Scheduled construction program for the 36-in. blooming mill alterations is shown schematically in this diagram.

intermittently over several months. This was done to maintain maximum rolling mill production as long as possible, and only the alterations to the 36-in. mill proper were made during a seven-day shutdown. When judging the construction record, one must keep in mind that a number of very lengthy strikes during 1945 and 1946 crippled severely the manufacture and shipment of equipment ordered for the Fontana mill alterations, and consequently influenced greatly the construction schedule. The shutdown of only seven days for the performance of the complicated work involved in the change-over of the 36-in. mill proper, certainly must be considered a record.

Not shown on the construction record are several minor modifications of the auxiliary installation, all of which, however, tended to reduce the downtime and thereby to further increase the productivity of the mill proper. Also not shown are the important changes to the scale flume system and the installation of the roto-control excitation equipment for the main mill motor, which took place at a later date.

SUMMARY

Concluding this report, we can state that the conversion of the 36-in. mill as described above, has resulted in the improvements expected. The productivity of the Fontana rolling mill has increased from 500,000 tons per year to 1,200,000 tons per year. These production figures indicate that the down time on account of equipment failure must have been very low, which proves that the decisions upon which these modifications were made were correct.

Today, after five years of operation with the modified 36-in. mill, Fontana is faced once more with the same decision. A new expansion program, which includes a third blast furnace and an additional 225-ton open hearth furnace (the original 185-ton open hearth furnaces have all been uprated to 225-ton capacity), has been embarked on by Kaiser Steel Corp. These additional iron and steel producing facilities will result in increased production for the rolling mill. Again, not as a matter of choice, but rather on account of different application of the available funds, no new blooming mill is included in the present expansion program. The 36-in. mill is expected once more to take the additional load with the only major modifications to consist of a new entry and delivery table for the mill. These tables will be of somewhat heavier design than the present tables.

There is no doubt that there are limits to the equipment even of the best mill builder, and it is quite certain that the Fontana 36-in. mill will have reached its final capacity with this new additional load. However, the Fontana organization will exert every effort to see to it that this mill does a creditable job toward reaching the objectives of the new program.

DISCUSSION

PRESENTED BY

A. F. KENYON, Steel Mill Engineer, Industry Engineering Department, Westinghouse Electric Corp., East Pittsburgh, Pa.

E. C. PETERSON, Vice President Engineering, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

W. A. VOGT, Project Engineer, Kaiser Engineers, Inc., Oakland, Calif.

A. F. Kenyon: The author has presented an interesting account of the more important changes from the original installation at Fontana to enable the large

scale production of slabs for the plate mill in the 36-in. two-high reversing blooming mill, instead of rolling small bottom-poured slab ingots directly to plate as had been necessary with the original mill layout. However, he has made only brief mention of the electrical drive equipment on the 36-in. blooming mill, and some further comments regarding the electrical drive may be of interest.

The 36-in. blooming mill is driven by a 5000-hp, 50/120-rpm, 700-volt, single armature, direct-current reversing motor, having 1,445,000 lb-ft maximum emergency (circuit breaker) torque capacity. The 5000-hp reversing motor is supplied from a flywheel motor-generator set consisting of two 2000-kw, 700-volt, direct-current generators, 77,000-lb, 14-ft diameter steel plate flywheel, and 4500-hp, 6600-volt, 3-phase, 50-cycle, 490-rpm wound rotor induction motor. At 500 rpm synchronous speed, the total stored energy in the flywheel and other rotating parts of the motor-generator set is about 155,000 horsepower-seconds.

As the author has indicated in his paper, the 36-in. blooming mill is small as compared to the 40–44-in. or larger mills normally used to roll 10-ton or larger ingots to wide slabs, and likewise the 5000-hp motor drive is small as compared to the 7000-hp to 10,000-hp drives associated with the larger mills. It is immediately apparent that the wide slab rolling imposes much heavier loads than were contemplated for the structural breakdown operation for which the mill was installed, and that the electrical drive equipment must now operate under rather severe load conditions. To meet these severe operating conditions, some changes were made in the electrical equipment.

As originally installed, the 2000-kw supply generators had field frames formed from solid rolled steel slabs. Subsequent developments, as described in a paper presented by Clarence Lynn and W. H. Burr before the AISE at the 1947 Convention, "Improved d-c Generators for Reversing Mills," 1948 Proceedings AISE, p 113, indicated greatly improved commutation performance under rapidly changing load conditions by the use of laminated steel generator frames, and such laminated frames have been installed on the Fontana 36-in. mill generators.

A further improvement was the replacement of the original magnetic field control equipment with a modern rotating regulator variable voltage field control equipment. This field control equipment affords much better control of current swings during rolling and mill reversals, while at the same time providing greater generator and motor field forcing and thus faster acceleration and deceleration. This more effective control plus the improved generator commutation obtained with the laminated generator frames has enabled the 5000-hp drive to satisfactorily meet the heavy slab rolling requirements without undue maintenance.

Observations have been made while rolling 26 x 42-in., 16,000 to 18,000-lb ingots to 5 x 36-in. slabs in 19 passes, with reductions ranging up to 1-½ in., with rolling loads 200 per cent or more of motor rating during several passes of each ingot, and an occasional maximum rolling load approaching 250 per cent of full load. Roll diameter in the bull head pass was about 33 in. During these observations, it was noted that ingots as large as 30 x 42-in., 23,350-lb were used for some orders, in one case being rolled to 4-½ x 36 in. slabs in 25 passes. The overload relay which trips the generator field circuit breaker, but which permits resumption of operation by merely centering the master switch, is set at about 14,000 amperes or 240 per cent of rated full load, and it operates several times per turn. The main circuit breaker between the generators and reversing motor is set at a higher current, and it trips only infrequently.

The author has commented upon the raising of the pinion stand and motor by the insertion of 9-in. thick fillers under the pinion stand and motor, thus locating the bottom pinion from 7-½ to 9 in. above the bottom roll, and requiring the bottom spindle universal couplings to operate at a fixed angle of about 3 degrees. He indicates that there was some concern that operation at this fixed angle might cause excessive wear of the spindle carrier and coupling slipper plates, however, several years operation has indicated that there were no detrimental effects from this angularity. It may be noted, in passing, that on most mills with twin-motor drive, the lower roll drive motor is located 12 to 15 in. lower than the lower mill roll, so that the lower spindle operates at a fixed angle of 2 to 3 degrees, and this usually has not caused particular trouble, although undoubtedly the spindle carriers must be more accurately aligned and better maintained than may be permissible when the spindle operates at practically zero angle.

I understand that an 86-in. continuous hot strip finishing mill is being installed following the original two-high and three-high plate mill stands, and that the slabs produced by the 36-in. blooming mill will be rolled to strip as well as to plate. The blooming mill can produce slabs up to only 36 in. maximum width, hence a great deal of spreading work must be done to enable production of say 80-in. wide strip, and the narrow slab must be correspondingly thicker to provide the weight to finish a long strip. Several plants already able to produce 48 to 54 in. wide slabs have recently made alterations to existing mills or have installed new mills to enable rolling still wider slabs, and it would be interesting to hear Mr. Vogt's comments as to whether the limitation in maximum slab width imposes any restriction on the operation of the plate and strip mill.

E. C. Peterson: Mr. Vogt mentioned that the maximum angularity of the top spindle was kept constant by raising the pinion stand, and I should like to inquire as to what that maximum angularity is at maximum working roll opening.

W. A. Vogt: In order to avoid misunderstandings, I should like to repeat that by raising the pinions by 9 in. we intentionally placed the slight angularity on the bottom spindle, but avoided an increase in the angularity of the top spindle, which ordinarily would result from an increase in roll opening.

For all practical reasons we can state that the working conditions of the top spindle were unchanged from those provided in the original design. Therefore, the maximum angularity of the top spindle after the alteration of the mill, at maximum working roll opening, still is approximately 9 degrees-50 minutes.

STEEL DEFECTS COMMONLY ATTRIBUTED TO HEATING

By GEORGE BOAL
Supervisor of Metallurgical Control
Crucible Steel Co. of America
Midland, Pa.

. . . . defects may be minimized by training furnace and mill operators in understanding the defects which may occur in the heating process . . . .

▲THE conversion of ingots to slabs, blooms and billets, and the subsequent reduction of these products to strip and bars all require heating. In all heating operations where the temperature is high enough for hot working, hazards are met in pit and furnace operations that will often result in a loss of steel.

It is often very difficult to determine whether the defects in the rolled material are caused by over-heating or under-heating, or by any of the non-standard deviations that occur in heating, or whether it is caused by improper melting or pouring. Certain grades of steel have a naturally poor rolling characteristic and will exhibit a surface that has all the appearance of being over-heated. Actually the steel is very coarse grained, and will not take normal reductions on the mill without cracking or tearing.

The purpose of this paper is to discuss the reasons for some of the defects encountered in heating, and to consider the actual harmful effect on the surface of the steel from heating. There are many things to be considered in heating operations that have a direct bearing on the quality of the steel rolled. In analyzing furnace operations, we will consider open furnaces with the flue gases resulting from combustion making direct contact with the steel. The properties of high temperature gases making contact with steel will affect the steel in various ways. The factors involved are the chemistry of the gases which include moisture content and sulfur content, air-gas ratio and furnace pressure. We will analyze these briefly under the subject of fuels.

FUELS

Table I gives the carbon dioxide, water and sulfur contained in flue gases from perfect combustion expressed in pounds per million Btu fired.

The primary factor in all heating is the fuel used for combustion and the subsequent effect of the flue gases on the steel. For the entire range of fuels, these flue gases consist of varying amounts of carbon dioxide, water vapor and nitrogen, when the theoretical amount of air is supplied and perfectly mixed with the fuel. In practice, the atmosphere also contains either oxygen from an excessive supply of air, carbon monoxide and hydrogen resulting from a deficiency of air, or a mixture of all of these gases resulting from a poor mixture of air and fuel. The effect of sulfur in the combustion

TABLE I

Fuel	Carbon dioxide	Water	Sulfur
Bituminous coal	202	32.6	0.43
Fuel oil	157	61.6	0.27
Tar	188	40.5	0.51
Natural gas	145	96.3	neg
Coke oven gas	126	106.2	1.41
Blast furnace gas	450	neg	neg
Bituminous producer gas	280	45.5	0.80
Anthracite producer gas	283	46.0	0.35
Butane	162	74.4	neg
Propane	158	73.8	neg
Artificial gas	189	114.0	neg

gases in either the form of hydrogen sulfide or sulfur dioxide causes excessive scaling. It also has an effect on the surface quality of the rolled steel by making the steel hot short, but it is rather hard to determine just how intense the effect is. Another important consideration is moisture content, and it becomes very important on mills that roll to finished size material that has a low decarburization specification. When excessive moisture is present, wet hydrogen is formed, which is the worst decarburizing combination of all the gases present.

The furnace pressure is very important in the consideration of decarburization by the flue gases. When there is a negative furnace pressure, free air enters the furnace. The oxygen from this free air, as contrasted to nascent oxygen through the burners, is nearly as decarburizing as wet hydrogen. The only method of eliminating this influx of air is to maintain a positive furnace pressure of about 0.01 in. of water by controlling the amount of flue gases going out the stack of the furnace.

The air-fuel ratio as supplied to the burners of open fired furnaces has a large effect on the resulting decarburization and scaling, because it directly affects the analysis of the flue gas. With a deficiency of combustion air, we have a reducing atmosphere where a part of the hydrogen of the fuel is oxidized to water, while the remainder stays in its original form of hydrogen to produce a combination which we know is a bad decarburizer. With an excess of air and good combustion, all of the hydrogen is converted to water vapor, which is less active as a decarburizing agent than wet hydrogen. Excess oxygen is also present, which increases the rate of formation of scale. For these reasons, it is found that the net decarburization after removal of scale is at a minimum when using an oxidizing atmosphere.

In products in which decarburization is not a major factor, either because of the chemistry or because of the amount of reduction applied, the opposite operation is frequently preferred. With a heavily reducing or smoky atmosphere, the amount of scale formed is materially reduced. The relative tightness of the scale formed, a subject which has certainly not been catalogued in any definite way to date, is also determined by the furnace atmosphere. For example, when heating stainless steel containing nickel, an oxidizing atmosphere tends to produce a free, loose scale that is easily removed; whereas a reducing atmosphere results in an adherent scale. Other alloying elements can reverse this situation.

RATE OF HEATING

This factor is of outstanding importance, greater than any of those factors already mentioned, and yet it is most frequently neglected. The rate of heating, expressed in pounds of steel heated on each square foot of furnace hearth, is a measure of both the time of exposure and the temperature to which the surface of the steel is subjected. If the rate of heating is too low, the time of exposure is excessive, and if the rate is too high, the furnace temperature will sometimes be too high for good results unless the time can be accurately and positively controlled.

Furnaces for heating billets and slabs fall into the following types or combination of types:

1. Batch type in-and-out furnaces operated at high temperatures.
2. Batch type in-and-out furnaces at preheating and finishing temperatures, with auxiliary equipment for rapid transfer of pieces from one furnace to the other.
3. Continuous furnaces for final heating.
4. Continuous furnaces for preheating and batch furnaces for final heating.
5. High speed heating—a recent development with a very high temperature with a very short time, which has produced several noteworthy accomplishments.

The actual numerical values for rates of heating are frequently argued, but with little or no reference to quality of heating. For example, in continuous furnaces, low carbon slabs may be heated at rates exceeding 100 pounds per square foot per hour with good results, but the same rates on alloy billets would produce a record amount of scrap. For these materials, the average rate is kept about 50 pounds per square foot per hour. Where 50 pounds result in excessive decarburization from time of exposure, the batch furnace is usually selected for the heating process because of its flexibility in control of both time and temperature. The average rate of heating in batch furnaces is again 50 pounds per square foot per hour, with a maximum of 60 pounds for good results, and a minimum of 25 pounds for high grade tool steels. It is when a wide departure from the 50 pound rate is found that heating difficulties are also most frequently found.

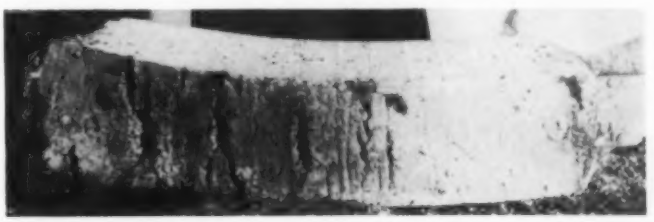

Figure 1 — This defect occurred because the ingot was much too hot on the one side.

It is interesting to note in passing that 4-in. alloy billets have been sucessfully heated for rolling in 8 minutes in high speed heating furnaces, without harmful effects, with a furnace temperature of 2800 F. This has revolutionized metallurgical thinking, but to date the necessity for exceeding the normal rate of heating by accurate control of time has limited the application of this principle to a relatively small number of installations.

TYPICAL STEEL DEFECTS — INGOT ROLLING

When considering steel defects in rolled products, many are very obvious and can be seen with the eye as a surface defect. Figure 1 is a typical example of a defect of this kind. The picture shown is a partially rolled ingot of electric furnace steel of the following analysis:

C	Mn	P	S	Si	Ni	Cr	Mo	Va
1.02	0.25	0.011	0.017	0.15	0.07	0.08	0.04	0.21

This is an AISI 52,100 grade that was cast in 20 x 23 in. molds with each ingot weighing 7090 pounds. The

Figure 2 — Since the corners get the hottest, the defects on this bloom are limited to these corners.

holding time in molds for this grade of steel is 2 hours. The total holding and track time for this particular heat was 2 hours and 35 minutes, and the pit heating time was 5 hours and 25 minutes. The defects show that the ingot was much too hot on the side shown with the defect. The sides of the bloom that are not shown had a normal surface. In analyzing this particular defect, we will note that the broken side of the bloom was at a temperature high enough to oxidize the grain borders. This results in a structure that has very little ductility and will practically fall apart in the rolling operation.

Figure 2 shows the same burning defect on a bloom of the same grade of steel. The burning is limited to the corners of the bloom which is usually the part of the ingot that gets the hottest. When a piece of steel is badly burned in the reduction of the ingot to a bloom or billet, the piece is scrapped, because subsequent rolling will again produce the same surface defects. In the case of a corner being nipped, this can sometimes be chipped or scarfed off, and the bloom can be rolled to a good bar. This, of course, depends upon how deep the penetration of the grain border oxidation has progressed.

It often happens that the ingot is in the pit for the proper length of time, and the rolling temperature is correct for the grade, but the steel still shows very obvious defects. Figure 3 exhibits what can very easily happen when a cold ingot of critical grade is charged into a soaking pit or furnace that has not been chilled properly before charging. This picture shows a partially rolled ingot of AISI 1095 steel of the following analysis:

C	Mn	P	S	Si	Ni	Cr	Mo	Va
0.97	0.36	0.013	0.030	0.20	0.07	0.13	0.05	0

This particular ingot was a sticker and was charged at a temperature of about 150 to 250 F. The ingot was heated by a normal cycle. On the fourth pass on the blooming mill, the heavy fractures shown in the picture appeared. The fractures are very deep, and in all likelihood, the ingot would have fallen apart if rolling was continued. An ingot like this is not recoverable. This type of defect differs from the burning defect in several ways. In the first place, the fractures occurred soon after charging the ingot into the soaking pit, while the examples of burning occurred at the highest temperature that the steel attained, which is near the end of the heating period. The structure of the fractured piece is normal and does not show excessive coarsening, which was obvious in the burned samples. It is always a hazard when it is necessary to heat ingots of high hardening grades that have gone cold for one reason or another. They should be charged in a black pit or a preheating pit. The temperature should be raised very slowly, particularly through the range from cold to 1000 F, until the ingot begins to show color. The ingots should then be heated in a normal manner. Even with the greatest precautions, fractures and bursts often occur.

Figure 3 — This defect occurred because a critical grade was charged into a furnace which had not been chilled properly before starting.

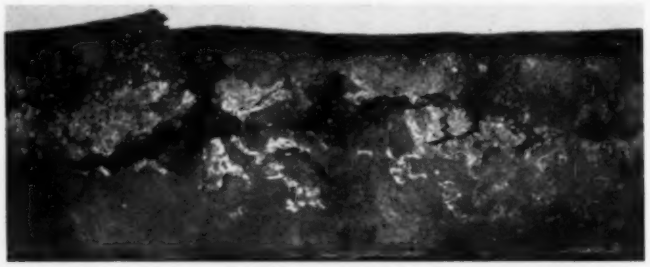

Figure 4 — In a continuous furnace, when the metallurgical analysis varies from one batch to another, it may be desirable to run a number of dummy billets through the furnace.

It must be remembered that in heating an ingot, you are heating a casting that is in a highly strained condition when charged into the furnace. That is why a very important thing to remember when heating sensitive grades of steel is that the first part of the heating cycle is to more or less equalize the temperature of the ingot and the furnace before proceeding with the heating cycle. This equalizing allows the center and surface of the ingot to even out in temperature, and it is much easier to heat an ingot evenly that has been equalized immediately after charging to remove the strained condition.

BAR ROLLING

The heating of billets for rolling to bars is entirely different from a metallurgical standpoint from ingot heating, in that the billets are cold, and also that the cast structure has been removed by previous hot working. One of the things that is often encountered in billet heating in pusher type furnaces is a high carbon order following a low carbon order. The low carbon billets must be heated to a much higher temperature than the high carbon billets, and as a consequence, as the last of the low carbon is being rolled, some of the high carbon billets are in the high temperature zone of the furnace. Figure 4 illustrates what can happen. The picture shows a 4 x 4 billet of 1095 carbon steel which has gone through two passes of a twist-guide roughing train. The surface is badly ruptured from burning. This was caused by the hearth temperature of the furnace

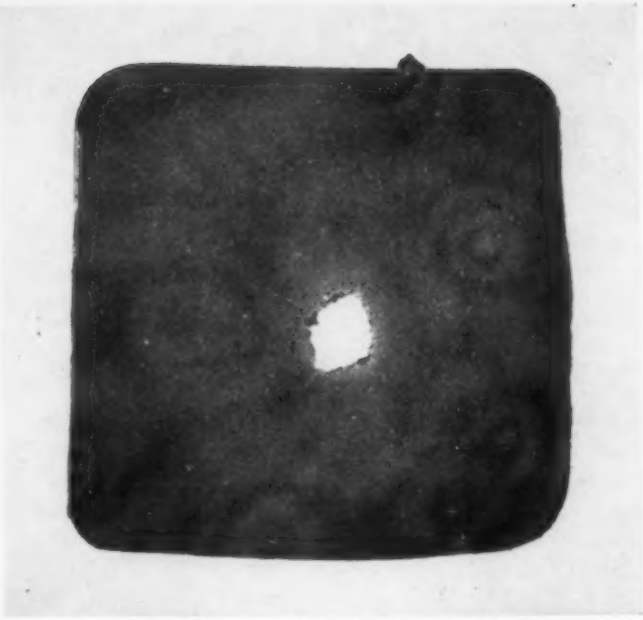

Figure 5 — Defects cannot necessarily be detected on the mill.

being maintained at too high a temperature for the grade. This practice of mixing grades in a continuous furnace very often presents this problem. About all that can be done to help the situation is to cut the furnace back as the high carbon material approaches the high temperature zone of the furnace and roll the last of the low carbon material at a lower temperature, which generally gives scale and section troubles, or to use dummy billets between grades. With a normal flow of low carbon to high carbon orders this condition very seldom occurs. The burned defect illustrated is very obvious.

Figure 5 is an illustration of damage that can be done to steel by heating that cannot necessarily be detected on the mill. The sample shown is a transverse section from a semi-rolled billet of AISI 52100 steel. The billet was charged in a batch furnace without proper chilling for this grade of steel. You will notice the hole in the billet. The strains set up at charging were so great that the billet burst, and the action of rolling opened the hole larger. Figure 6 shows a longitudinal quarter section of the same billet. The hole does not run the complete length of the billet, which is typical of this condition. Defects of this type are more likely to happen in batch furnaces than in continuous furnaces, because the billet will probably be charged at the same time the furnace is being discharged, even though the furnace is not being fired on the end being charged. It is quite often necessary on the more sensitive grades of steel to discharge the furnace completely and chill back the whole furnace before charging, in order to eliminate this type of defect, which is the reason for using continuous or batch type preheating.

Figure 6 — The rolling action opened the hole larger, although this type defect does not ordinarily run the complete length of the billet.

DECARBURIZATION

The phenomenon of decarburization or loss of carbon from the surface of steel takes place in conjunction with scaling, and the two processes are closely associated with each other. The factors involved are the time at temperatures, the amount of mechanical working, the furnace pressure, the air-fuel ratio and the kind of fuel used. These were discussed earlier in the paper, with the exception of mechanical working.

When heating steel for rolling to bars, we must realize that we will always have a certain amount of decarburization, because all open fired heating causes decarburization. The thing to do is to operate the furnace in such a way as to have a minimum amount of decarburization. The amount of mechanical working involved in rolling the billet to a bar is very important in the problem of decarburization. We will illustrate this with an example taken from the book "The Heating of Steel" by M. H. Mawhinney, which shows what happens to the decarburized skin by reduction of cross-sectional area. The area of the sides of a 4 x 4 billet, 12 in. long is 192 sq in. If this billet is rolled to a round bar of one-inch diameter, the length becomes 245 in., and the new area of the surface is 768 sq in. The increase in area (or decrease in depth of decarburization) will be 400 per cent. In other words, the depth of decarburization on a one inch diameter round, when rolled from a 4 x 4 billet, will be about one-half as great as on a two-inch diameter round rolled from the billet, and about one-fourth of that on the billet after heating but before rolling.

In general, we can say that the tendency to decarburize increases with temperature, because the reaction between the carbon and the gases of the furnace is increased by temperature. However, the oxidation of iron also increases with temperature, and there are cases where a reduced decarburization after removal of scale is found with high temperatures, because the scaling has been increased to a greater extent than the decarburizing. Another phenomenon—the diffusion or migration of carbon from unaffected to decarburized areas—also affects the final results, and the effect of temperature on this factor is not as yet well understood.

We have seen some of the defects that occur in rolling that can be directly attributed to improper heating. We have not attempted to go into the mill difficulties encountered from uneven heating of billets for bar rolling, where the section is difficult to maintain from unevenness of temperature. Only the more obvious defects have been considered. We all know that improper furnace operation does occur in spite of the greatest precautions. With an effort to make the furnace operators and mill operators conscious of the defects that can occur in heating processes, most of the troubles can be eliminated.

Water Symposium

. . . . the steel industry in Pennsylvania is carrying out a sound and sensible approach to overcome the problem of water pollution . . . .

"LIQUID WASTE TREATMENT"

By C. S. CASSELS
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▲ THIS paper will describe briefly the liquid waste treatment unit recently placed in operation at the Philadelphia plant of Henry Disston & Sons, Inc. Located in the northeast section of Philadelphia along the west bank of the Delaware River, this plant employs about 2500 people. The main production processes include the melting, rolling and forging of alloy steels, and the punching, heat treating, and grinding operations required in the production of the Disston line of tools.

Plant service installations include capacity for the production of 250,000 pounds of steam per hour at 125 psi, and the generation of 2250 kva of 60-cycle alternating current at 2400 volts. Approximately 3,800,000 gallons of water are used daily by the plant, of which 15,000 gallons is filtered water supplied by the municipal mains; the remainder is raw water pumped directly from the Delaware River without treatment other than coarse screening.

The major applications for water are: condenser cooling, grinding coolant, boiler makeup, and furnace and mill cooling water.

Prior to the installation of the treatment plant, about 85 per cent of the liquid wastes were discharged directly to the river while the remainder was carried off by the city sewer system.

In 1947, the proper authorities of Pennsylvania requested studies of the quantity and character of the wastes discharged into the Delaware and the submission of plans for the elimination of those discharges found to be in violation of the Pure Streams Act.

The resulting investigation developed the fact that plant wastes were discharged to the river through 17 different sewer outlets ranging in size from 8 to 27 in. diameter, and with outfall elevations varying from —7 to +1, mean low tide being —6. These sewers were distributed along some 1250 ft of river front.

The contaminants included:

1. Oil from process operations and lubricants.
2. Abrasives and iron particles from grinding operations.
3. Spent pickle liquor.
4. Sanitary wastes.
5. Mud, oil, etc., drawn into the system from the river with the incoming water.

The volume and character of the discharges from the individual sewers varied widely, their loads naturally conforming to the processes and activity in the area served. Because of this condition of variation, no attempt was made to assemble and analyze a composite sample. Instead, measurement and sampling of the individual discharges were made where possible and the resulting data used to determine the quantities of wastes to be handled and the method of treatment to be used.

The plan finally submitted to and accepted by the state was based on the following decisions:

1. Cooling water from the steam turbine condensers would continue to be discharged to the river untreated.
2. Wastes from the western section of the plant would continue to be carried off by the city sewer system.
3. The balance of the wastes, estimated at 1,200,000 gallons per day, would receive treatment before discharge to the river. It was further decided that, with the exception of pickle wastes, all flows concerned would be collected and treated at one point. Pickle liquors would be neutralized at point of origin.

In arriving at the decision on this third item, consideration was given to the possibility of diverting all contaminated wastes to the city sewers. This solution was ruled out when it was determined the city would

require a reasonably thorough treatment of the plant wastes before their acceptance into the sewers. Thus it would be necessary to construct treatment facilities similar to that required by the state, and at the same time be subject to an appreciable yearly charge for sewer rent.

The physical plant finally developed and installed in accordance with the above basic decisions, can, for descriptive purposes, be divided into three sections:

1. The gravity interception system.
2. Pressure transmission system.
3. Treatment plant.

The interceptor system consists of a collection basin into which the plant wastes are carried by two gravity sewers, which for the most part parallel the river. These sewers have a total length of 1775 feet of which 1400 feet are 15 in. concrete pipe and 375 ft are 48 in. The low level interceptor chamber into which these lines discharge is located near the mid point of the river frontage. It consists of a reinforced concrete chamber, 24 feet deep, with a maximum capacity of about 50,000 gallons. The wet section of the chamber is divided into two parts, either of which can be isolated for cleaning or repair.

The pressure pipe system transfers the collected wastes from the interceptor chamber to the treatment plant. Two 600-gpm and one 2000-gpm individually motor-driven centrifugal pumps are located in a dry well adjacent to the wet section of the interceptor chamber, and are so piped that any or all pumps can pump from either or both chambers of the wet well, and any pump can be isolated for removal and/or repair.

A recording level controller automatically starts the pumps in sequence as the head of water in the interceptor chamber rises. The 2000-gpm pump is used as the reserve pump, being the last to start and is therefore, normally idle except during heavy rains. Operating records show that under conditions of maximum head in the interceptor chamber, the three pumps deliver a total of 4000 gpm or 260 per cent of the estimated dry weather flow into the interceptor chamber wet well.

If, under heavy storm conditions, greater flow is experienced than can be handled by the pumps, the excess passes over a weir into a 48-in. overflow line to the river. As it is anticipated such a condition will develop extremely infrequently, this practice is approved by the state. The pumps are connected to the treatment plant through 1450 feet of 16-in. cast iron pressure pipe.

The treatment equipment consists of a sedimentation basin having two parallel compartments and a total capacity of 270,000 gallons. This capacity provides for an estimated three-hour retention during periods of normal plant operation in dry weather. Both compartments have a group of submerged porous tubes near the entering end through which low pressure air is forced to aerate the raw wastes. Skimming equipment is provided to remove the oil from the surface of the water.

At the bottom of each compartment, at the discharge end, are two sludge hoppers into which the settled sludge is drawn by a wooden flight type sludge scraper. These scrapers, travelling against the flow at the surface of water, and with the flow along the bottom of the tank, serves the dual purpose of moving the scum on the surface to the skimmer and dragging the sludge to the hoppers.

Two sludge pumps are so installed in an adjacent dry well that either or both can handle sludge direct from the sludge hoppers or from the wet well adjacent to the sludge hoppers and deliver it to any or all of four earthen lagoons, each of about 90,000-gal capacity. Decant from the lagoons flows by gravity back to the wet well where sludge pumps return it to the sedimentation basin. The effluent produced by this aeration, skimming and settling flows by gravity through a 20-in. diameter concrete pipe to the river without further treatment.

During the "break in" period various operation schedules were tested from which developed the simplified system now in use.

All work is performed on the day shift, the system operating unattended nights and Sundays. This is permissible only because it has proved satisfactory to operate the sludge scrapers and pumps once daily, usually in the morning. The sludge pumps are only operated during the periods of scraping, but the blowers providing air for aerating the raw wastes run continuously.

Other than operating the sludge removal equipment, the duties of the operator consist mainly of lubricating and adjusting the equipment and collecting and checking samples.

This plant has been operating about five months, a time too short to permit the development of conclusive operating records. Samples are taken from the incoming river water, from the collected raw wastes and from the effluent discharged. An average of the weekly tests of these samples for two months, shows the following:

	River Water	*Raw Wastes*	*Effluent*
pH	6.98	6.99	7.01
Oil/ppm (Ether extracted)	16.5	29.7	19.1
Suspended solids, ppm	29.4	102.5	30.9
Iron, ppm	1.19	8.4	3.2

These preliminary checks indicate that the treatment plant, while not producing an effluent of higher quality than the present river water, is at least removing almost all of the contaminants resulting from this particular industrial operation. This we understand to be the primary purpose of such treatment.

This very elemental treatment installation demonstrates the practical approach the State of Pennsylvania has made to the problem of stream purification. The plant approved was considered the minimum unit which could possibly produce the necessary results. While planned provision was required for future expansion and additional treatment facilities, their construction was not demanded until and unless the basic unit proved inadequate. Thus we were not required to make expenditures for treatment steps which might have proved unnecessary.

"LUKENS WATER PURIFICATION SYSTEM"

By N. H. JENSEN
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Coatesville, Pa.

▲ THE history of steelmaking in Coatesville began in 1810 with the formation of a company known as The Brandywine Iron Works and Nail Factory. Since the mill depended upon water for its power, it was located on the west branch of the Brandywine Creek. This creek has its head waters about twelve miles north of Coatesville in the Welsh "Mountains" and is fed by numerous tributaries as it flows southward. Its volume was more than adequate for the water-wheels of the past and has continued to be so all through the growth of this original company into the present. Lukens Steel Co., among its facilities, has twelve open hearth furnaces, a 120-in. mill, a 206-in. mill capable of rolling the world's widest plate, flanging and pressing shops, fabricating and welding divisions, and other departments concerned with specialty manufacturing such as the alloy-clad, steel plates.

The importance of Brandywine Creek to the operation of this modern plant is easily appreciated when it is realized the volumes of industrial water that are required to keep such facilities in production. The Brandywine supplies the major portion of this water but bears an additional burden of equal importance, that of carrying away the industrial wastes created in the operation of the plant.

In the past, contamination of waters was not considered serious but as industry grew, the volumes of wastes became progressively greater throughout the country. As the pollution grew, the public became more conscious of the need for ridding the streams of these wastes. In 1937, the Commonwealth of Pennsylvania enacted a "Clean Streams" program, Act. 394, P. L. 1987. In compliance with this act, Lukens during 1946, began its design of an industrial waste treatment plant.

BASIS OF DESIGN

The West Branch of Brandywine Creek flows through the center of Lukens Steel Co. Gaugings in recent years show that its average flow is 30,000 gpm. Minimum flow during the dry years of 1941 and 1944 was 5600 and 3500 gpm respectively. Maximum flow during a flood of 1942 was 9,000,000 gpm. The stream as it arrives at Lukens is relatively clean, having little or no industrial contamination present.

The total average consumption in Lukens plant is approximately 14,000 gpm, a volume considerably greater than the minimum flow of the creek during dry weather. To overcome this, a recirculating water supply was constructed during World War II in which the water is taken from the Brandywine Creek at a point below the mills, pumped into a storage reservoir of 25,000,000 gal capacity. From here it is pumped through a 30-in. pipe line back to the mill units. After being used, the water discharges into the creek and flows down to the original point of pumping, completing the circuit. At points along the creek, there are also pumping stations supplying various other sections of the mills. This system not only serves as storage but also dissipates the high heats absorbed by the water

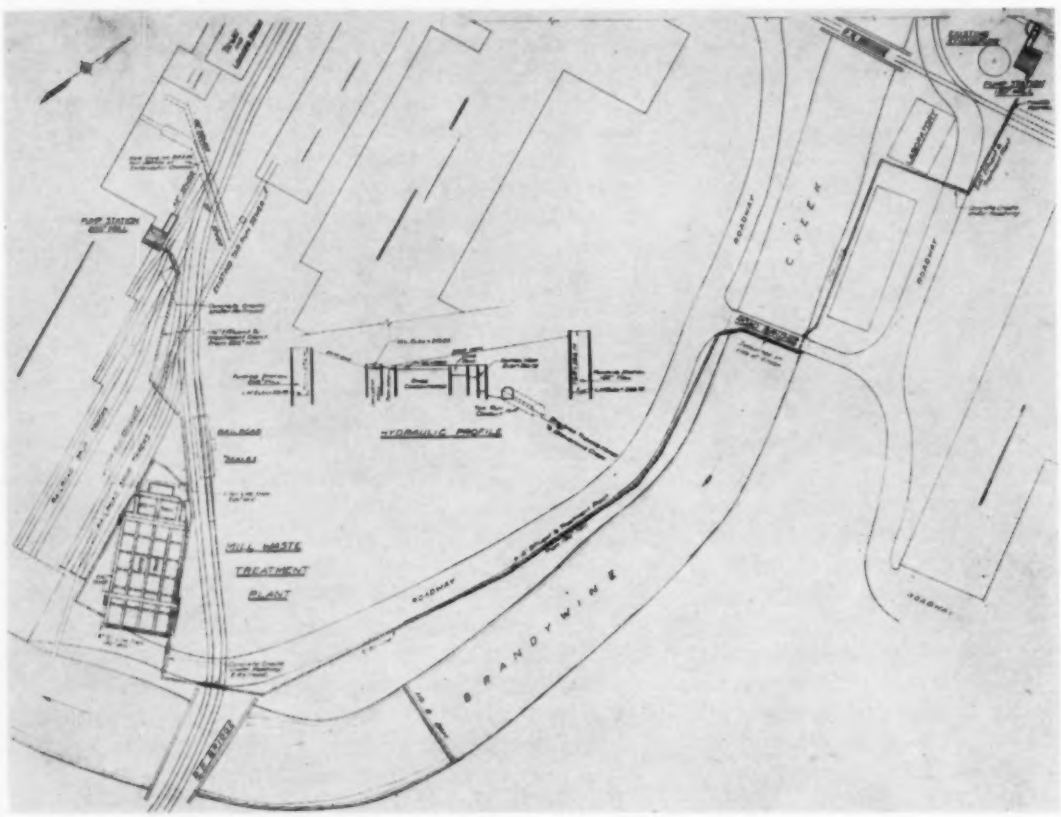


Figure 1—Layout of industrial waste treatment plant at Lukens Steel Co.

in passage through the open hearth doors, condensers, and other heat exchangers. The importance of a waste treatment system for this supply is easily understood.

In investigating which of the facilities contributed wastes needing treatment, it was found that only the waste waters from the 140-206-in. mill and the 112-120-in. mill contained sufficient contamination to require purification. Analysis of the effluents from the remaining sections of the plant showed no need for treatment, which was expected, since their function is one primarily of cooling.

The basis of design for the waste treatment plant is for a discharge flow from these units of 7000 gpm or approximately 10,000,000 gallons per day. Chemical analysis reveals the presence of oil and iron oxide in the amount of 3.6 lb per 1000 gallons of discharge water.

CHOICE OF DESIGN

The first method of treatment considered was a chemical precipitation process in which alum and lime would be added in mixing chambers to the waste waters collected from the two mills. The effluent from this mixing operation would be piped to either one of two large cylindrical tanks where the suspended solids would coagulate and settle. The clear supernatant would be drawn off into the creek at an approximate pH of 7.4 while the resultant sludge was pumped to a battery of centrifuges. Here the sludge would be concentrated into a semi-dry solid, easily handled in consequent dumping operations. A tentative market was established for this recovered iron oxide.

Next, a pilot plant for securing samples of the wastes was erected east of the 206-in. mill building. It consisted of two steel tanks to receive the wastes pumped from the main mill sewer. Below these tanks, a smaller one was arranged for drawing off and decanting the sludges precipitated in the upper tanks. The pilot plant operated for two months in early 1947 and treated 25,770 gallons.

As a result of this sampling, it was found that treatment of 10,000,000 gallons per day of waste water would require 8,180 lb of aluminum sulfate and 3560 lb of hydrated lime to produce a sludge cake containing 18,000 lb of available iron oxide in the form of FE_3O_4. On the basis of these facts, a tentative design for such a plant to handle these quantities was started. As the design progressed, it became increasingly evident that this method was not suited to our requirements. The process was found to be excessive in labor costs since seven highly-trained men would be necessary to operate it for a 24-hour period. Chemical costs per day would be over $300. In addition, such a plant would cleanse the waste waters far beyond the purity of the Brandywine itself before it reached Lukens. Furthermore, the recovery of iron oxide, and its subsequent sale, was to be a factor in offsetting the high cost of operation. This method of separation would contaminate the oxide with objectionable sulphur compounds, seriously reducing its market value. The alum-lime process was therefore abandoned.

The second method of treatment considered was a design in which basically, the floating oils would be skimmed off the effluents from the two mills, the suspended solids being allowed to settle, without chemical treatment, in large tanks. A filtering bed would then be provided to remove any unbroken oil emulsions overflowing from the settling tanks. This is the method chosen since it was the most adaptable to our operations and the present industrial waste treatment plant is based on these principles. The following discussion deals with the detail of this design and results accomplished.

DESIGN AND OPERATION

The layout of the industrial waste treatment plant is shown in Figure 1. The effluents from the two mills are intercepted by two pumping stations which pump the waters approximately 350 ft from the 140-206-in. mill and 1200 feet from the 112-120-in. mill to the treatment plant, where after purification they discharge into a sewer flowing into the Brandywine. In general, treatment takes place at three points in this system, the first being trash racks ahead of the pumping station. The second point is in the pump stations where oil is partially removed, and the third, the treatment plant which removes the solids and the remainder of the oil.

The pumping station at the 140-206-in. mill (Figure 2) is essentially the same as at the 120-in. mill so that the following description will serve for both units. The waste-laden effluents from the mill reach the pumping station through large sewers in which have been installed a weir with an adjustable sluice gate that can be opened during floods or pump failure, diverting the wastes from the pumping station. Below this overflow system, is a trash rack which removes the burlap bags used in the rolling mill to descale stainless steel plate. It consists of a rack of vertical steel bars spaced to give ¾-in. clear openings and anchored in the floor of the sewer. As the rack traps the bags, continuously operating rakes with teeth projecting through the bar spacings move vertically up through the rack, catching and depositing the bags into a pan for quick disposal. The rakes are pulled by sprocket chains and powered by a ¾-hp motor with a reduction unit to give a rake speed of 10 fpm. The water then flows into the pump well where floating oils are removed. This is accomplished by a steel trough, the weir of which is kept just below the surface of the oil. The vertical adjustment of the trough, to compensate for varying water levels, is effected by a float which activates a hydraulic cylinder, raising or lowering the trough to maintain its set depth beneath the surface. The skimmed oil is pumped from the trough with a ¾-hp pumping unit, through a 2-in. line to an oil sump at the treatment plant.

From the pumping station, the partially-treated water is pumped to the waste treatment plant by means of three vertical propeller type, two-stage pumps. Powered with 20-hp induction motors, one variable speed, their individual capacity is 1750 gpm at 30 ft total head. With the one constant speed pump running at a set discharge volume, the variable speed unit, through an automatic float control, varies its discharge to maintain a relatively constant level in the

pump well. The third pump is held as a spare. It was necessary in the 120-in. mill station to increase the pump motors to 25-hp because of greater distances and increased lifts. The line leading to the treatment plant proper is 16-in. diam and has installed at the low points, blow-off valves for removal of accumulated settlement. Automatic air relief valves are also provided at the high points.

provides a 60-minute detention time at 10,000,000 gallons per day, the horizontal velocity through the tanks being 0.02 fps. Tests show that the No. 8 to No. 100 mesh solids settle in 20 minutes. Finer particles (200 mesh and smaller) are occluded in the floating oil scum which requires 30 minutes to form. This would require a tank length of 36 ft at 0.02 fps. Our effective settling length is about 60 ft per tank which allows the plant

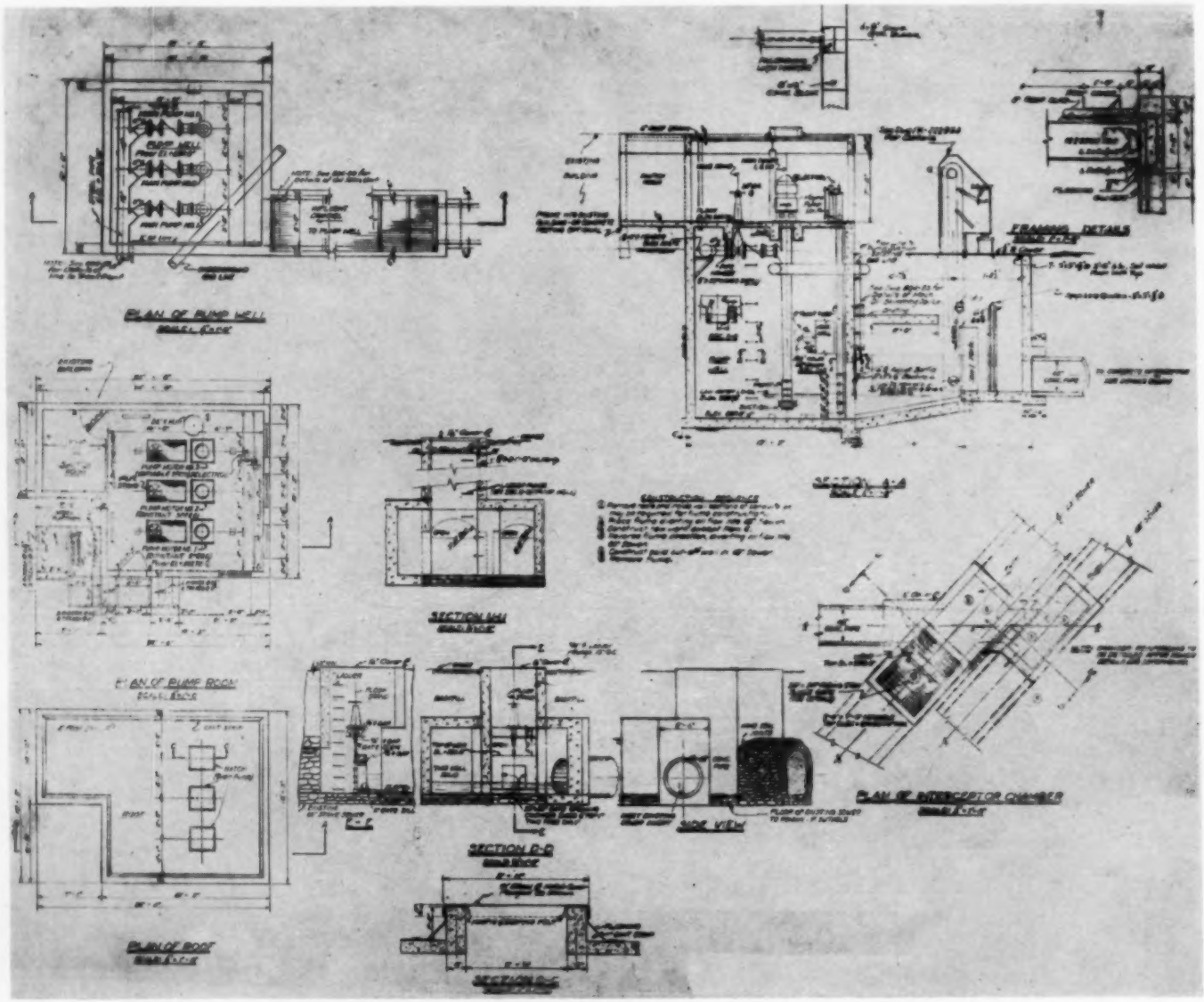


Figure 2 — Details of pumping station are given in these drawings.

The 16-in. lines lead into the influent well (Figure 3) on the east side of the plant from which the water is distributed through a 24-in. line into the four oxide concentrator tanks with a valve at each tank to equalize the flow. Also 10-in. gates are provided in the partitions separating the tanks for further balancing flows to obtain an operating level of the water 2 ft 0 in. below the top of each tank. One or more tanks can be closed off and drained through a 12-in. pipe at the north end of the system, allowing the remaining tanks to function as usual.

The four oxide concentrator tanks are of reinforced concrete throughout with 15-in. concrete partitions separating them. Each tank is 13 ft 0 in. wide, 90 ft 0 in. long and 17 ft 4 in. deep. This battery of concentrators

to operate with three cells if necessary. During this detention period, the solids settle to the bottom where it is collected by a system of flight scrapers traveling 2 fpm. The flights are spaced 5 ft 0 in. apart, constructed of 6-in. channel, and are pulled by a sprocket chain powered with a 1-½-hp, induction motor with a worm gear reduction unit. The bottom of each tank is sloped on each side to the 3 ft 10 in. wide flights which are held ⅛-in. above the bottom by means of rails imbedded in grout. The flight scrapers operate for the full length of the tanks and at the point where they pass under the influent line, a baffle has been placed to prevent the inlet turbulence from washing the collected sludge from the scrapers as they go up the south, inclined end of the tank to the scraper discharge chute. The settle-

ment here drops from the chute to the sludge pans which are then removed at necessary intervals.

The water during the settling of oxides has moved northward to the end of the concentrator tanks carrying with it, the floating scum of oil not removed at the pumping stations. Here it encounters a concrete baffle extending five feet below the surface, under which the water must flow, leaving the oil behind. Oil removal from this point is accomplished by a set of flight skimmers in each tank consisting of 2 x 6-in. redwood flights 11 ft 4 in. long spaced 15 ft 0 in. apart and pulled from a point 30 ft 0 in. out in the tank at 5 fpm with a sprocket chain on which the flights are attached. Each

original position. We have found that this operation is necessary once every two days.

From the skimming pipe, the oil flows by gravity through a 4-in. line to the oil sump which measures 2 ft 0 in. x 5 ft 0 in. x 6 ft 0 in. deep and is placed on the outside of the No. 4 concentrator tank. This sump also collects the oil from the skimmers at the pumping stations. Two sump pumps with a capacity of 50 gpm at 15-ft head, lift the oil into a 4000-gal steel storage tank located 6 ft 0 in. above ground level. It has a 2-in. valved outlet for drawing off the collected oil into drums, and a 4-in. overflow line at its top leading back into the No. 4 concentrator tank. In addition, there is a 4-in. drain

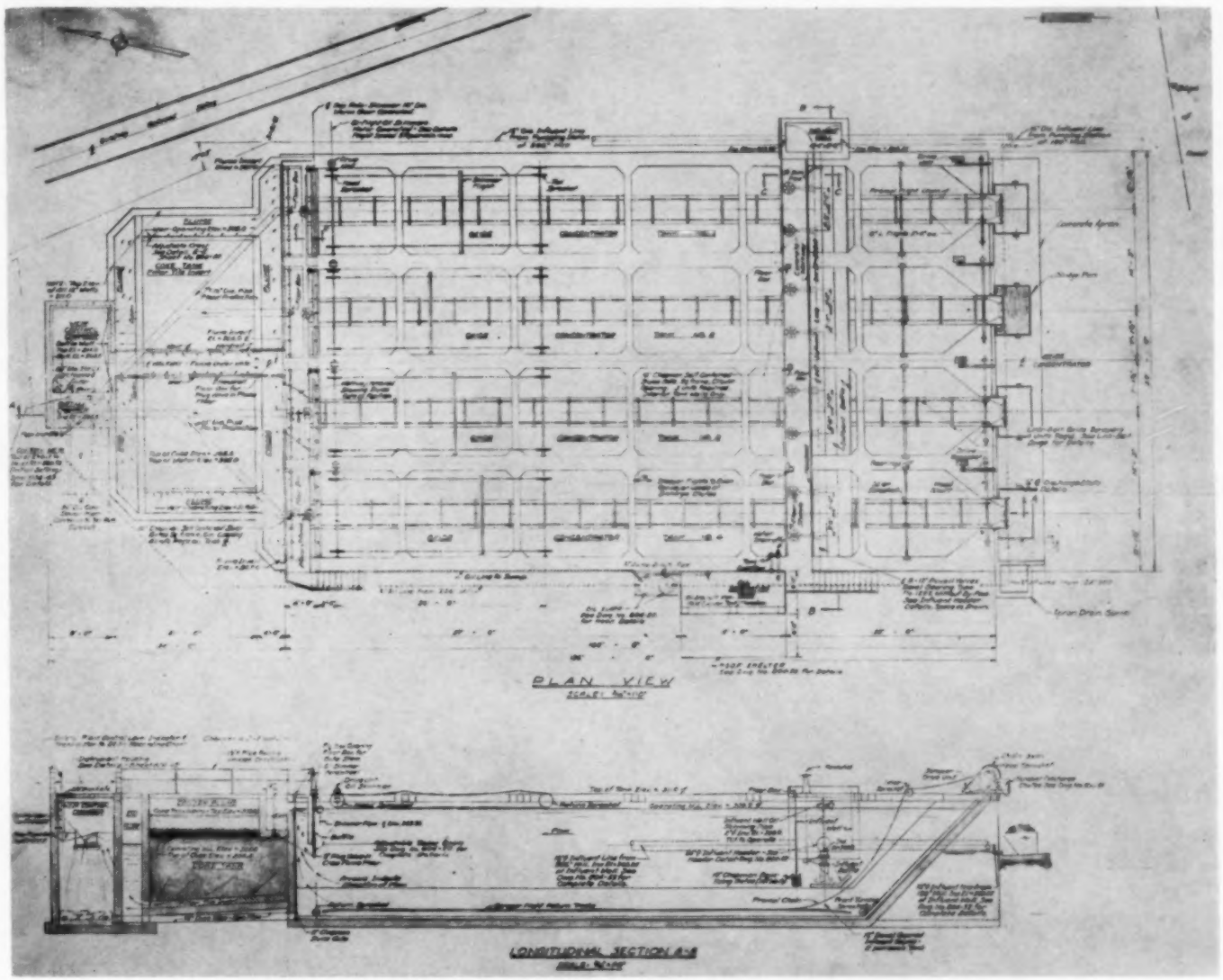


Figure 3 — Section and plan view show details of waste treatment plant.

of the four sets are powered by a common worm gear drive, with a ¾-hp induction motor. The flights move from out in the tanks, pushing the oil to the north end, where an oil skimmer consisting of a 10-in. slotted pipe is located partially below the surface. The lip of the slot is just above the level of the oil and by means of a hand wheel can be rotated about its longitudinal axis to the desired depth below the surface for skimming the oil. By careful manipulation, water carry-over is at a minimum. The pipe is then rotated back into its

line in the bottom for drawing any water that may have come over from the skimmers.

COKE FILTER BED

As the water passes from the concentrators and under the oil baffle, they flow over a weir into the cross flume which leads to the flumes at the coke beds. Here the water passes over aeration weirs and falls two feet

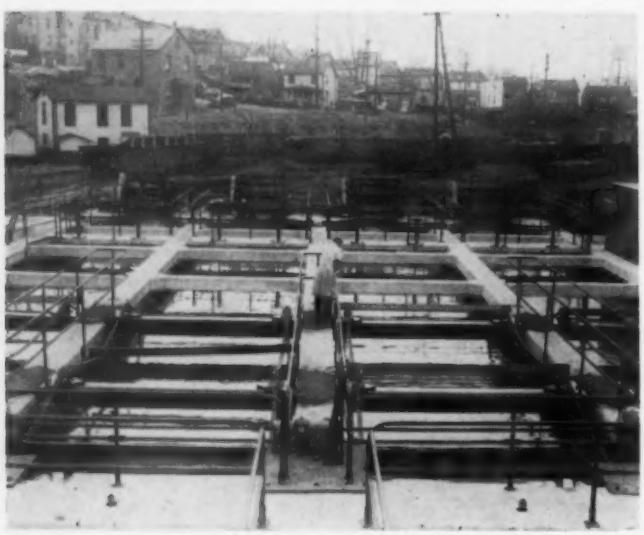
contacting the coke which removes any remaining suspended solids. The bed measures 20 ft 0 in. wide, 42 ft 0 in. long, 15 ft 6 in. deep and is filled to a depth of 10 ft 6 in. with clean, coarse coke. The effluent from the bed flows through slotted vitrified clay tile at the bottom of the bed and into an end flume which acts as an additional oil trap. From the flume it flows into the control chamber; over a control weir and into the sewer pipe leading to the Brandywine Creek. If more complete treatment is required in the future, the elevation of the outfall weir is such that another plant could be interposed between this weir and the creek. Built over the control chamber is a small instrument house which

Figure 4 — Water flows through coke bed and over aeration weirs.

contains a recording flowmeter giving the instantaneous flow or the accumulated flow over a 24-hour period. The building also contains the switches and related equipment for the operation of the motors of the oil sump, flight skimmers and scrapers. The coke bed and weirs are shown in Figure 4.

A general view of the oxide concentrator tanks is seen in Figure 5. The flight skimmers are shown in Figure 6 and the sludge collection in Figure 7.

Figure 5 — Oxide concentrator tanks are also used to collect oil scum.



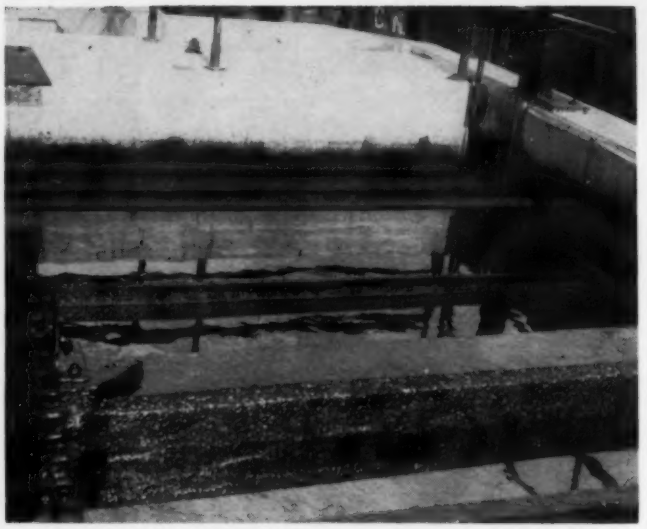


Figure 6 — Oil is removed by oil flight skimmers.

RESULTS

The waste treatment plant is not completely finished since there are several units yet to be installed. These units are the oil skimmers in the pumping stations, the trash rack and the concrete apron with its sludge pans.

Average flows through the plant have been 3800 gpm or 5,500,000 gallons per day in recent months. Peak flows have reached 6000 gpm or approximately 8,500,000 gallons per day, 18,000 gal of oil have been recovered in the past initial year of operation, and is reclaimed by using it to supplement our "Bunker C" fuel oil supply.

The flight scrapers have removed approximately 140 tons of sludge which consists of iron oxide with considerable quantities of lint and oil. This low oxide recovery is due to the oil and solids forming an emulsion

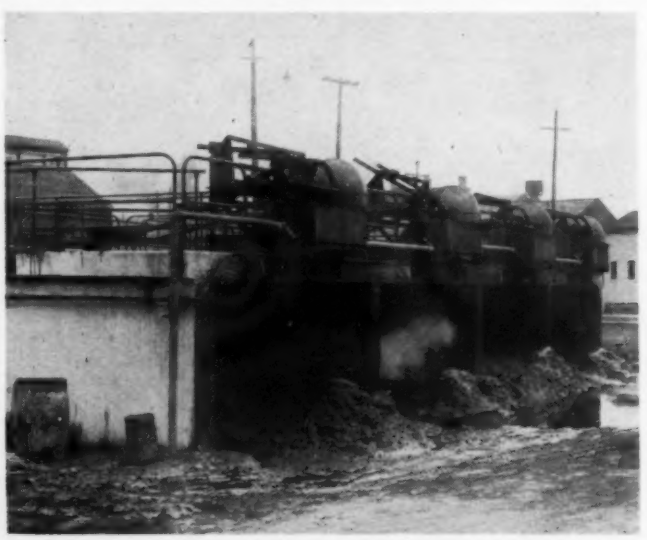


Figure 7 — Sludge from flight scrapers is collected as shown.

at the pumps in the pumping stations, causing a suspension which does not settle in the concentrator tanks. Installation of the oil skimmers will reduce this emulsification to a minimum.

An increase in the rolling of stainless steel plates has

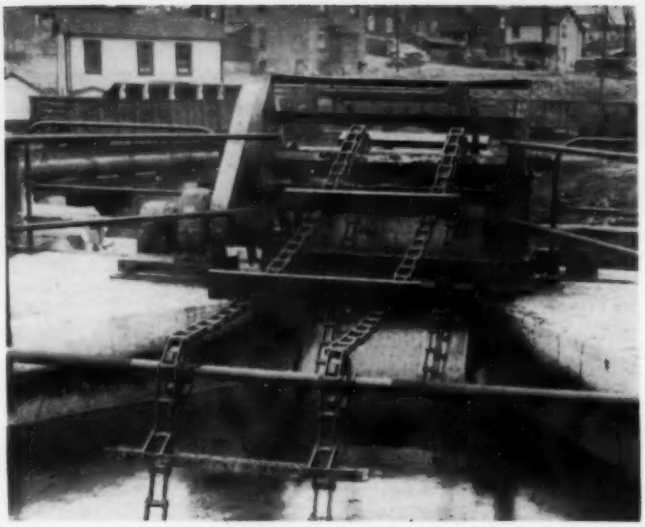


Figure 8 — This is closeup of flight scraper shown from the opposite direction to that given in Figure 7.

brought with it the problem of burlap bags in the wastes which was not anticipated in the original design. At present, we are using removable screens which must be cleaned daily. It is felt that installation of the continuously operating trash rack will result in an efficient method of bag removal.

SUMMARY

The waste treatment plant, while not completely finished, is doing quite well in removing oil and suspended solids from the waste water. With the installation of the units needed for completion, it is hoped that the efficiency of the process will improve, resulting not only in full compliance with the commonwealth's program but also cleaner water to our mills.

"CURRENT PRACTICE IN WATER POLLUTION ABATEMENT"

By B. P. MARTINEZ
Process Engineer*
Bethlehem Steel Co.
Sparrows Point, Md.

▲ THE Sparrows Point plant of Bethlehem Steel Co. is abating its stream pollution from suspended solids and rolling oils well below the legal maximum set by the State of Maryland. Acid wastes have been diminished, and a process of regenerating spent pickle liquor is being developed. A plant designed to treat 9000 gpm of waste water from the cold-reducing mills is being erected. The oil and water from this plant will be fit for re-use on the mills and will be recirculated in separate streams.

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Sparrows Point (see Figure 1) spreads over more than 2000 acres of land occupying the point of a peninsula which juts into the Patapsco River, where that river empties into Chesapeake Bay about 12 miles southeast of Baltimore in Maryland. It has annual steelmaking capacity of over 5,000,000 tons, or almost 14,000 tons a day. For this production, more than 337,000 gpm of water is used by Sparrows Point, either salt water, fresh industrial water, or well water. About 7000 gpm of well water is for sanitary use by more than 25,000 employees, for boiler water make-up, and for miscellaneous uses. Approximately 250,000 gpm of salt water is taken from the Patapsco River and is used mostly for heat exchange work, with the balance going to direct cooling and washing of blast furnace gas. No salt water is used directly on any steel product. Over 30,000 gpm of fresh industrial water, varying in temperature from 45 F in the wintertime to 88 F maximum in the summertime, comes to Sparrows Point from the sewage disposal plant of the City of Baltimore, at Back River, about 5 miles away. Most of the industrial water is used for direct cooling in the shaping and treating of steel products. Industrial water is also used for furnace cooling, and in air coolers. The rest of the industrial water is used for quenching coke, processing coke oven gas by-products, and in blast furnace gas disintegrators and electrostatic precipitators.

Of all this water used but little is evaporated, and a total of about 337,000 gpm finds its way to the Patapsco River carrying additional matter or energy it did not previously have. This matter and energy are identified as industrial wastes. However, the title of this paper is "Stream Pollution Abatement at Sparrows Point." Therefore two definitions are needed: Pollution of a stream occurs when there is free discharge into it of industrial wastes so that injury or restriction is effected on the ordinary life functions and habits of plants, animals, or humans. But when discharge of industrial wastes is controlled short of injury or restriction to plants, animals, or humans, abatement of pollution is accomplished.

Figure 1 — The Sparrows Point plant of Bethlehem Steel Co. is located on the Chesapeake Bay at the mouth of the Patapsco River.

Although more than 337,000 gpm are used and discharged by Sparrows Point, over 452,000 gpm are actually handled. The difference represents recirculated water. The recirculation of water not only conserves water, but in some installations, facilitates pollution abatement by accumulating wastes to a salvageable concentration.

The one overshadowing fact in pollution abatement at Sparrows Point is the tremendous amounts of water discharged from its sewers. Other than mechanical energy of velocity, Sparrows Point discharges heat energy to the surrounding streams equivalent in rate to as much as 1000 hp. And this involves an increase of temperature never more than 10 F above that of the original source to Sparrows Point.

But prodigal use of water alone does not abate pollution from flue dusts, mill scale, spent pickle liquor or oil wastes. These are pollutants which are abated at Sparrows Point.

Flue dusts and mill scale in sewer effluents are inert, suspended solids which settle readily to the bottom of a body of water into which they are dumped. Not being soluble, they are not taken into the respiratory or digestive processes of aquatic plants or animals. They have a profound influence on certain aquatic organisms which require the catalytic effect of sunlight on their metabolism. This effect is photosynthesis. Metabolism is the life process by which matter and energy outside an organism is changed into other matter and another type of energy within the organism. In some organisms, oxygen is a raw material for the change, and in others oxygen is a product of the change. All living matter constantly carries on metabolism. These organisms, which require sunlight, are identified as the phytoplanktons, and are principally found in the family alga. If the concentration of suspended solids in sewer effluents is large enough, sunlight does not sufficiently penetrate the receiving body of water, and the population of these phytoplanktons when living close to shore is reduced. The importance of these phytoplanktons is in that oxygen is a by-product of their metabolism. Oxygen in streams is required by the more complex aquatic life for their own metabolism, and reduction of number of oxygen producers would eventually reduce the available amount of edible sea food. Remember that natural life is a delicate balance of factors wherein disease and death are the aftermath of disbalance. Work performed on Baltimore Harbor, including the Patapsco River, has indicated a daily photosynthetic oxygen production on the order of 15,000 pounds per square mile. We have installed sufficient equipment whereby discharge of flue dust and mill scale into the local streams is an inconsequential total amount, and therefore the effect on photosynthesis is inconsequential. Figure 2 and Figure 3 are of equipment for mill scale removal.

The largest source of flue dust in a steel mill is the blast furnace. Blast furnace gas is a fuel, but it must be processed in several steps in order to remove a practical maximum of dust. The gas leaves the furnace top at such high velocities that it unavoidably carries with it considerable dust. Most of the dust is removed in a dry condition in the first piece of equipment, a dust catcher, and from there dumped into gondola cars for transport to a sintering plant. Most of the remainder is removed in a counter current water washer, and the last traces are removed in wet cyclones and disintegrators, and electrostatic precipitators. All the waters from all these installations are, or will soon be, conducted to thickeners which remove the flue dust in the form of a slurry which is filtered, and the cake in turn is also sent to the sintering plant. The thickeners at Sparrows Point are over 90 per cent efficient in removal of suspended solids. In this manner, when equipment now being erected is in operation, more than 1350 tons a day of flue dust will

Figure 2 — Scale pit is used for primary removal of mill scale.

Figure 3 — Settling basin shown is used for recirculated water for 68-in. hot strip mill.

be salvaged for the sintering plant, and only a negligible total amount of flue dust will be discharged into the local streams.

In shaping steel, high pressure water is used as jets to strip off scale. The scale flows with the water into large settling basins where it is periodically removed with crane buckets. Approximately 550 tons per day of mill scale are removed from these settling basins to be sent for direct charge to the blast furnace. (See Figure 2). After settling of the scale the water is recirculated through cooling towers, or through spray ponds, and then sent back for reuse. (See Figure 3). Enough water from the settling basins is discharged to sewers, and make-up water is added to the basins to further lower the temperature of the water. Most of these settling basins discharge into Humphrey's Creek, which is entirely within the plant boundary. Therefore most of the mill scale finds its way to the bed of the creek rather than to the local public streams.

The disposition of spent pickle liquor is one of the important problems of the steel industry. Sparrows Point discharges primarily into Chesapeake Bay, a large body of salt water which exerts a complete buffer effect on the sewer effluents. Although free acid is discharged by the sewers, tests of the water in midstream of the river on whose shore Sparrows Point is located, yield essentially neutral reactions. The 300,000 gpm of water which Sparrows Point takes from the Patapsco River causes no corrosion to the pipe or equipment from free acidity. Nevertheless we are concerned with spent pickle liquor because it contains great quantities of sulfur, and sulfur is critically short in America today. This last consideration is impelling us to intensify our efforts to decrease the dumping of any acid or acid salts into the neighboring streams. Some success has been achieved.

At this point, very definite differentiation should be made between sanitary wastes and industrial wastes. Very competent engineers have long ago devised methods of treating and disposing sanitary wastes. It is to their particular credit, when one comprehends that while total flow may be controlled and anticipated, concentration and composition of sanitary wastes may neither be controlled nor be anticipated. And understand that only in extraordinary circumstances is the treatment of sanitary wastes a profitable undertaking. Fundamentally, sanitary waste is an unwanted substance.

Industrial wastes should not be considered or handled as are sanitary wastes. Today great segments of American industry are occupied in the reclaiming of very-much-wanted and profitable industrial wastes. The coke oven department of every steel mill is a classic example of reclaiming. In contrast to sanitary wastes, concentration and composition of industrial wastes may very definitely be controlled and anticipated. Many industrial wastes are daily being turned into products for profit. Nevertheless some industrial wastes are handled as an afterthought in massive and expensive waste treatment plants, which reclaim nothing, by sincere people intent primarily on conforming to state laws. In contrast, Sparrows Point conforms to Maryland state laws by the preferable methods of recirculation, good housekeeping, and the salvaging of usable by-products.

Sparrows Point has abated the pollution of streams with spent pickle liquor by adjusting its pickling techniques to reduce the amount of acid consumed per ton of steel pickled. Today, by cascading and recirculating pickle liquor alone, Sparrows Point has reduced the acid consumption rate by about 20 per cent. It has reduced the losses of acid to rinse tanks by using more efficient rolls on the steel outlet tank of the continuous picklers where most of the acid used for pickling is consumed.

Loss to fume scrubber systems has been sharply reduced. A fume scrubber system is a classic example of where an atmospheric pollution problem has been transformed into a stream pollution problem. Because of the great dilution intrinsic to fume scrubbing, abating of pollution from such a system is extremely difficult. At Sparrows Point, pollution from fume scrubber systems has been abated by limiting the number of systems. This is possible because the amount of fumes is kept down. How is this done?

Any liquid, subject to evaporation from a horizontal surface with air flowing parallel to that surface, evaporates at a rate dependent on the velocity of the flowing air, and the difference in vapor-pressure between the liquid and the air. Now most of the acid used by the steel industry for pickling is sulfuric acid, and sulfuric acid solutions in the concentrations and the temperatures used for pickling have negligible acid vapor pressure, even when boiling occurs. It can be categorically stated that with ordinary engineering methods of measurement, no detectable sulfuric acid leaves a pickling tank by evaporation. It leaves as an entrainment of the pickle liquor itself, along with evaporated water. This entrainment is intensified by the agitation in the pickling tank as well as by the near boiling condition of the pickle liquor, and it is removed in proportion to the evaporated water removed. Therefore we minimize removal of acid by the fume scrubber system by minimizing the amount of water evaporated.

Figure 4 — Studies were made on recovery of pickling liquor in this pilot regeneration plant.

In the new continuous picklers at Sparrows Point, the five pickling tanks are closed by five contiguous

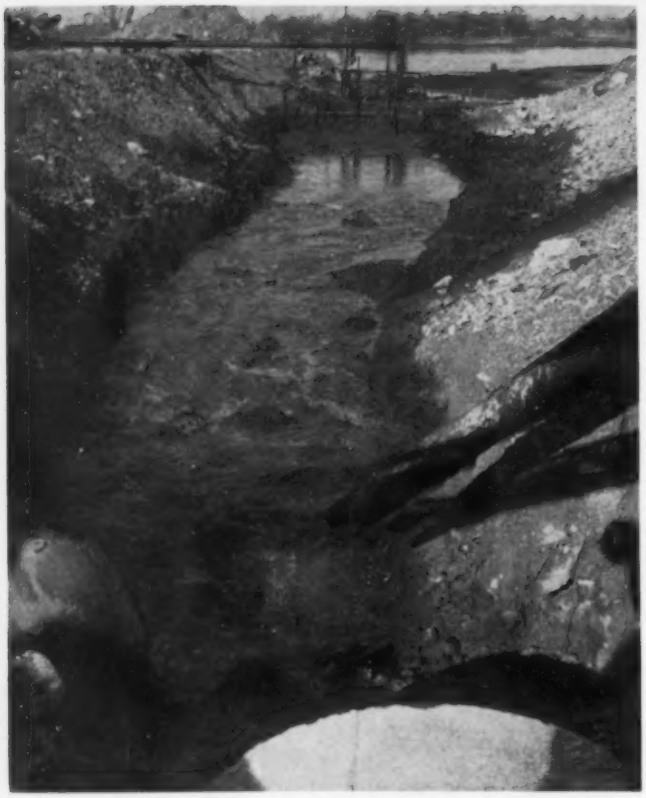


Figure 5 — Oil which escapes skimming in the mills is salvaged by lagooning the outlet of the sewer.

covers with only two openings, one at each end, instead of the old-fashioned five separate covers and therefore ten openings. Instead of five fume scrubbers with take-offs from the middle of each pickling tank cover, there are only two, one fume scrubber with one take-off adjacent to the steel inlet opening, and a second fume scrubber with one take-off adjacent to the steel outlet opening. In this manner, only leaking air passes over most of the liquid surface in the pickling tanks, the velocity is therefore low, and the acid entrainment is at a minmum. But developments in acid economies are not at an end. Methods are under consideration which may entirely eliminate the use of water in fume removal, and therefore eliminate stream pollution by fume scrubbers.

Along with the rest of the steel industry, we know of methods to neutralize pickle liquors and lagoon the product, or attempt to sell it. We also know of a method to barge the spent pickle liquor far out to the Atlantic Ocean. Not only are all these methods economically unsound, but they are wasteful of sulfur, a critically short raw material.

We are making pilot plant studies of the regeneration of spent pickle liquor for continuous re-use of the free acid which is unavoidably dumped along with the unwanted ferrous sulfate. (See Figure 4). We likewise are making pilot plant studies of the manufacture of sulfuric acid from ferrous sulfate. As the price of sulfuric acid increases, complete regeneration of spent pickle liquor will become less of an economic burden.

Oil as an industrial waste is more a nuisance than a true interferer with the ordinary life functions and habits of plants, animals, or humans. For convenience it will now be considered to be a pollutant. The one overshadowing fact in pollution by oil is that so little can affect such a huge area. One drum of oil worth about $10.00 can cover several square miles as a slick which would cost several times ten dollars to remove. However, most of the oils used in a steel mill are worth more than $10.00 a drum, and Sparrows Point carefully conserves its oils.

Discharged rolling oils cause a difficult pollution problem. In cold rolling of steel a large amount of water is applied to one location, and a small amount of an emulsion of rolling oil and water is applied to another location.

Because of the intrinsic design of the cold reducing mill, water and oil along with mill dirt are all discharged together. Formerly the mixture was discharged to the local streams because the concentration of oil in the Sparrows Point effluent was below the legal maximum concentration set by the State of Maryland. However the surrounding water area has in recent years been rapidly turning into a recreational center, and Sparrows Point is anxious to be a good neighbor to the people who share with it the many inlets and

Figure 6 — Pilot plant is used for salvaging cold rolling mill oils and water.

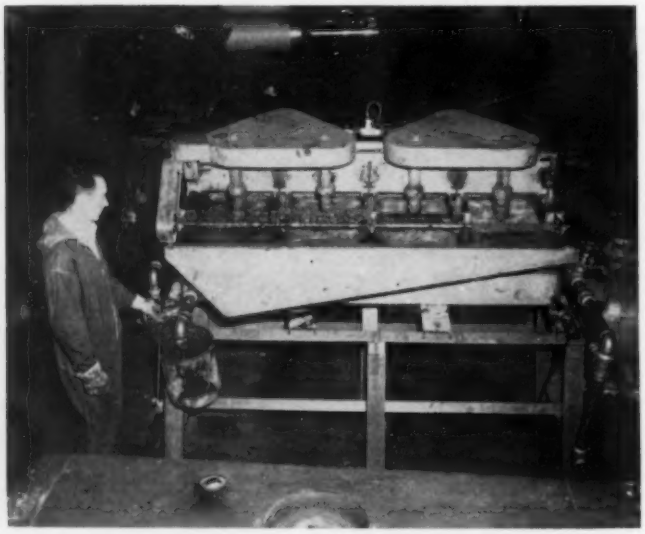
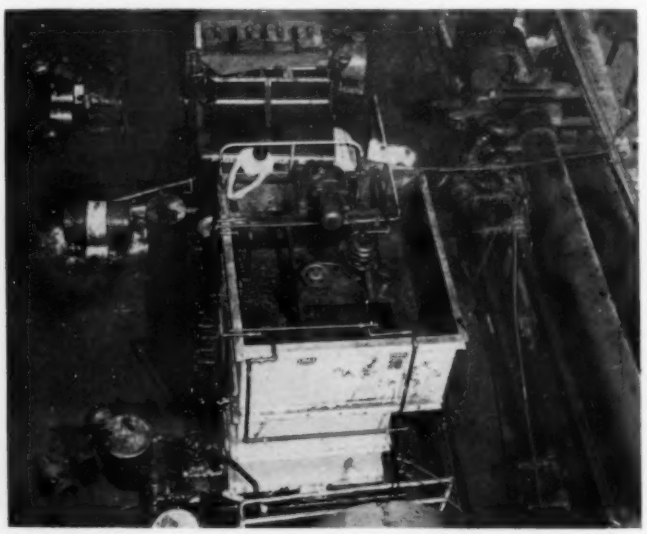


Figure 7 — Overhead view of pilot plant for salvaging oil which is also shown in Figure 6.



covers. At first, skimming oil in individual settling basins was successful in abating pollution from rolling oils. Later a skimming device was installed at the outlet of Humphrey's Creek to further reduce the amount of oil entering the surrounding streams. The skimmed oil was burned. Recently a simple oil reclaiming device was installed at the outlet of the sewer from which most of the rolling oils are discharged. (See Figure 5). Finally a process has been devised and is being installed to remove and treat the greater part of the oil before it even reaches Humphrey's Creek. This process will be carried out in a plant designed to treat 9000 gpm of waste water from all the cold reducing mills. Figures 6 and 7 are illustrations of pilot plants which led to the development of the process. This project, at first strictly a pollution abatement undertaking, is expected to be a profitable one, because the removed oil is being treated to be reused on the cold-reducing mill itself. The water likewise is being cleaned, but in a separate operation so that it too is fit for reuse on the mill. The mill dirt is definitely removed and discarded. Details of this operation will be published at a later date.

By these various methods, Sparrows Point abates its pollution. We at Sparrows Point consider pollution abatement to be not a separate problem, but a part of the making of steel. In our constant effort to produce quality steel economically, we will continue to diminish whatever wastes occur.

"OPERATING EXPERIENCE WITH WASTE WATER TREATMENT PLANTS"

By F. C. SCHOEN
Chief Engineer
Alan Wood Steel Co.
Conshohocken, Pa.

▲ THE Alan Wood Steel Co. in compliance with requirements of the Commonwealth of Pennsylvania, initiated a program in 1948 for removal of objectionable impurities from the water used in their plants before discharging this water to the Schuylkill River.

The following paper discusses three plant water systems, one located at steel works division at Ivy Rock, one at specialties division in Conshohocken, and the third at coke and chemicals division in Swedeland.

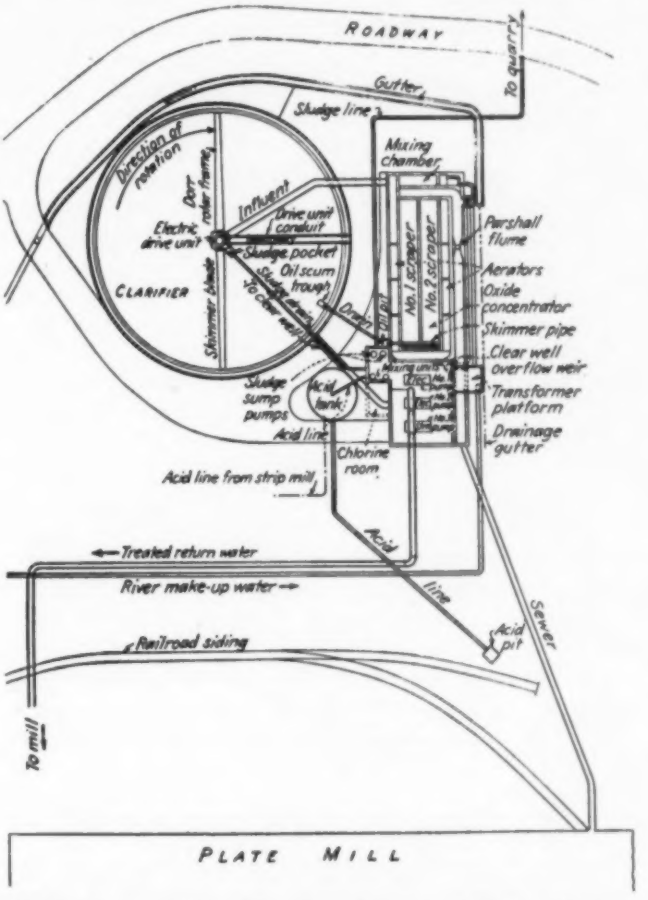
STEEL WORKS AT IVY ROCK

The steel works at Ivy Rock, originally built in the early 1900's, took full advantage of the fact that much of the plant area was at an elevation of some 43 feet above the Schuylkill River on its west, and also that a small stream ran through the east side of the property. Water was pumped from the river throughout the plant with more or less constant head being maintained by use of two 150,000-gal water tanks at the high point of system. Waste water returned directly to the river or to Plymouth Creek through sewers, which also carried off surface and building storm waters.

At the time construction was started for the 30-in. hot strip mill, water was being pumped at the rate of 7 to 9,000 gpm at a head on pumps of 140 ft. Of this gallonage, about 3000 gpm went to the open hearth plant, to be used for makeup and cooling on a recirculating cooling water system, which overflowed to Plymouth Creek.

During the design stage for 30-in. mill, it was developed that an additional 5000 gpm would be required and studies showed that even if existing water system were used by addition of more pumps, pressures would be insufficient for the new mill, due to existing pipe sizes.

During this same period, the Commonwealth of Pennsylvania had started their extensive program for cleaning up the Schuylkill River, and the necessity for returning clean waters to the river became important.



Compact arrangement of water treatment plant is illustrated in this layout. This is one of the first of this type to be used in the steel industry.

Various plans for a treatment plant, designed to remove major portions of mill scale, dirt, oils and greases were studied, and one difficulty experienced in the design, was the necessity for rerouting of existing sewers so that storm and rain waters would not mix with mill waters going to a treatment plant, as this overload would necessitate much larger than normal equipment, and the danger of releasing dirty water to the river would always be present.

Another design problem was created by the necessity of raising the head of entire water system, to meet the requirements of strip mill.

It was finally decided to install a recirculating system, designed to carry 12 psi greater pressure than formerly, retaining existing surge tanks but preventing their overflow and still maintaining system pressure by use of a shut-off valve in tank feed, controlled by elevation of water in the tanks.

This decision permitted installation of new pumping equipment with no down time, for going to higher pressures, utilizing existing river pumps for supplying makeup and cooling water, use of old pumping system in the event work was necessary requiring shut down of new treatment plant, and a storage capacity of 300,000 gal of water to maintain furnace cooling temporarily if pumps failed.

The new treatment and pumping plant takes a design flow of approximately 12,000 gpm of mill waste water, which flows by gravity from plate mill, blooming mill and strip mill through sewers and a Parshall flume, where flow is metered, to the oxide concentrator. This concentrator consists of two rectangular concrete tanks, each equipped with drag scrapers for removal of heavy mill scale which settles out during the 10-minute retention time of waste water. Rotary type oil skimmers are installed at discharge end of these tanks.

From concentrators, water flows through open channels equipped with riffles, to provide for some cooling. At the discharge point of these channels, river water is introduced through two lines. One line is for cooling as determined by temperature, and the other line provides makeup water as determined by the level of clear well. One reason for introduction of river water at this point is to provide the sometimes necessary clarification of river water. The total of makeup water and mill return water now flows to a circular clarifier which at a design flow of 17,000 gpm has a retention time of 45 minutes. The clarifier is equipped with an oil skimmer attached to top of scraper mechanism.

Oil collected by this skimmer, and the one on primary concentrators is drained to a sump from which it is pumped for final disposal.

After water leaves clarifier, it goes to clear well for return to plant system by means of centrifugal pumps. These pumps are each 8500 gpm, normally two electric pumps being in service with a steam turbine unit as standby.

Normally, makeup water amounts to approximately 4000 gpm as water used only for furnace cooling is discharged directly to the river, and since the total suspended solids in the clear well are kept below those of the river water and oils are not measurable, being at the most a trace, no difficulties have been experienced with this operation.

Sludges collected by gravity from clarifier are pumped to an abandoned quarry for disposal. Heavy scale collected in concentrators which is high in iron content is stored for future disposal at the blast furnace division.

It should be mentioned here that rates of flow in various mill sewers, with a single exception, have been high enough to prevent any settlement of scale where it was not wanted. This single exception, due to construction difficulties was practically level, and with extremely variable rates of flow, has given a considerable amount of trouble due to scale settlement.

Several other things happened to us shortly after plant went into operation in January 1950 which are mentioned here in the hope that someone else may profit by our experiences.

We soon found that the scraper mechanism on primary concentrators must not be stopped, as in a very short time the blades become embedded and units must be drained and shoveled out. Also considerable care must be taken not so much to get an equal volume of water through the units, if more than one is used, but to so divert and channel the water to get an equal diversion of solids. If when a unit is put in operation, one scraper is delivering considerably more volume of solids than others, do not postpone getting a balance as one unit may soon break down from overload.

One other condition was, and is, very noticeable and that is temperature. We were accustomed to having short periods during summer weather when river water temperatures reached 95 F, but as no further build up in temperature occurred this was not too serious, however, when recirculating and using river water for cooling, temperatures of 105 F became all too common, causing troubles on mills using fabric bearings, as well as excessive temperature rises in other recirculating systems such as the open hearth, due to high temperatures of makeup water.

We have noticed quite an increase in solids at primary concentrators as mill tonnages have increased, and in connection with the construction of an auxiliary waste water sewer from our strip mill, we are now providing an additional settling basin to remove more mill scale before sending the waste water to the treatment plant. It is our opinion that settling basins can be installed at a relatively low cost in sewers where small volumes of water are to be handled and thus help out final treatment.

Illustration shows concentrator. Pump house is shown in background.

SPECIALTIES DIVISION AT CONSHOHOCKEN, PA.

Our specialties division presented a somewhat different problem than the system just covered. Here the plant elevation is low, and while mill waste waters still returned to water of the commonwealth by gravity, we found it necessary to use pumping to properly handle wastes for treatment.

As at the steel works we again had a system in which waste water and storm waters flowed throughout com-

Concentrator shown is located at specialties division.

Discharge end of concentrator.

mon sewers, so that one major item in setting up a treatment system was separation of mill waters from storm waters.

At this plant, mill water is pumped from the Plymouth canal, which is supplied by Plymouth dam on the Schuylkill River. Mill wastes were returned to this same canal. Since the volumes of water to be handled were small, reaching a maximum of approximately 1500 gpm, it was finally decided that the system need not be as elaborate as the one at steel works, and the system as approved by the Commonwealth of Pennsylvania consists of a common sump to which all waste waters return, located under a pump house having 3 1000 gpm submerged suction vertical type pumps. These pumps operate on float switch control, so designed that one unit is base and the other two operate, dependent on sump levels. Base pump can be made any one of the three and the others operate in sequence.

Waste water is pumped to a concentrator with scrapers similar to those previously described, but here the retention time at full capacity of 2000 gpm is 90 minutes. These concentrators are equipped with oil skimmers, and provision is made for installation of a coke bed to discharge water through if required. One item of the installation is the flocculator, installed to help on reduction of fine oxides obtained under certain conditions of sheet manufacture. This has helped eliminate the need for a clarifier in system. No provision had to be made for cooling, as concentrator discharge is located approximately 300 yards upstream in canal from suction of mill supply pumps, and this, together with constant flow of river water through canal provides water amply cool for our purposes.

We have had good results with the system, discounting trouble experienced with motor starters due to very frequent operation. Unfortunately insufficient thought was given to frequency of operation as we felt fluctuations would be short. The answer here is heavy duty equipment.

COKE AND CHEMICALS DIVISION AT SWEDELAND

In our coke plant, we have a group of gas producers used for fuel under one battery as well as controlling Btu content of gas. Cooling water from these producers contains small percentages of phenols and cyanides. Water is also used for flushing the ashes to a sump for disposal. Water for these services formerly was supplied from plant system, and the overflow from ash sump as well as cooling water flowed through plant sewers directly to the Schuylkill River. As may be imagined, this water not only had a heavy load of solids but carried other objectionable materials.

Many schemes were studied, primarily to remove the phenols and cyanides, but it finally appeared impractical to try any purification which would make waters suitable for return to the river. The final solution was to stop the return of all waste water which created an abatement, but has given us considerable work.

The system as designed and installed is again a recirculating system, with makeup water obtained from the river, but losses are obtained in two locations, one by evaporative cooling towers, and two by means of an overflow line to the coke plant quenching station.

The flow diagram for the system is simple, in that all cooling water which carries considerable solids as well as phenols, etc., returns to a sump by gravity.

From this sump, liquid is pumped to a circular clarifier, returning by gravity to a second sump. From here liquid is pumped over the top of cooling tower—cooled water returning by gravity to a third sump. From this last sump, water is then pumped back to gas producers. Makeup water is introduced at the last sump so that if any failure of equipment prior to this point occurs, we will still maintain cooling water. All sumps are set so that overflows in event of pump or equipment failure—run from clean, cool water in No. 3 toward dirty water in No. 1 sump. This sump overflows to ash pit which in turn is provided with pumps which discharge at quenching station. Flushing discharge from clarifier flows to ash pit. Flushing of ashes is handled by a small 100 gpm pump, taking water from ash pit on a recirculating basis.

All pumps in main pump house are paired up, one electric and one steam turbine driven.

After putting this system into operation during the

summer of 1951, one immediate difficulty was experienced. The load of solids carried by the water into No. 1 sump was quite heavy, and heavy settlement occurred here due to loss of velocity. This affected operation in two ways, first by clogging up foot valves of pumps and secondly by leaving only fine material go to the clarifier. Our tests on settling times used all material in waste water, and evidently the heavier material aided clarification, since after installation of jets from No. 1 sump pump lines to keep water in sump agitated, we have helped not only blocking of pump suctions, but improved the operation of clarifier.

Another precaution was taken in the design, to provide more than normal ventilation in pump houses with floor above sump sealed as tightly as possible. Sumps were also vented on one side of pump house. This precaution was due to the gases given off by waste water and possible injury to personnel in the pump house.

View shows main pump house clarifier and cooling tower at coke and chemical plant.

DISCUSSION

PRESENTED BY

LOUIS KOVACS, President, Palm Oil Recovery, Inc., Baltimore, Md.

F. H. DECHANT, Civil Engineer, Philadelphia, Pa.

N. H. JENSEN, Chief Engineer, Lukens Steel Co., Coatesville, Pa.

A. M. QUINN, District Representative, Parr Engineering Co., Philadelphia, Pa.

F. C. SCHOEN, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

C. S. CASSELS, Plant Engineer, Henry Disston & Sons, Inc., Philadelphia, Pa.

Louis Kovacs: The speakers discussed four instances of waste water, or effluent treatment, from steel mills. They all mentioned oil skimmers and that the oil is skimmed from lagoons or concentrators or scale pits, etc. Whether it was reused or just disposed of was not mentioned. I know of several plants that reuse their oils, partly or fully, and it is a thought I wish to leave with anyone in steel mills trying to solve the problem of waste disposal, to contemplate making enough money on recovered oils to pay for the process.

At the Sparrows Point plant of Bethlehem Steel, the waste oils collected from the cold rolling operations are treated in a plant for palm oil recovery, and refined for recycling and reuse in the cold mills.

Briefly, I would like to state that in our experience at Sparrows Point, it was possible to completely utilize all the recovered oil in the steel operation, for the original use it was used before, at a fraction of the cost of the original oil purchased. This was only possible through the very intelligent efforts made by the Sparrows Point plant in conserving the spent oils and it would be equally possible, probably at any steel plant, to devise a system of recovering partly or completely all the waste oils and save enough or profit enough by the operation to amortize any plant required for this complete treatment.

I would like to ask one question about the Lukens plant waste treatment where all effluents are collected in one system to be treated mostly mechanically and then discharged. These iron oxides that he mentioned, are those iron scale or also iron hydroxides? It was not clear to me what the actual waste materials contained in those waters were, and whether the contaminants in the Lukens system were similar to other steel mill disposal problems. It seems to me that a considerable part of these solids could be iron hydroxide, and treated as such.

F. H. Dechant: In answer to the question raised about the quality of the contaminants in the Lukens Steel Co.'s water, it might be answered in this way. A majority of it is iron oxide in the form of mill scale, in very finely divided form, after it reaches the sewers. It is contaminated at the present time with a great deal of lint that comes from the bagging or jute used for polishing stainless steel. After the removal of that lint, it is likely that the largest component of the waste will be iron oxide, or mill scale.

There are schemes on foot at both the Lukens Steel Co. and, I may say advisedly, the Alan Wood Co., who are going further in the recovery of oils than what they have already done after their systems are more completely integrated. We are believers, too, in the possibility of getting some recovery from the by-products of this clean-up program, of the Schuylkill River and the other tributaries of the rivers of our state.

N. H. Jensen: A question was asked regarding the recovery of waste of the water purification plant. We are at the present time using our skimmed off, salvaged oil from the basins by adding it to our Bunker "C" Oil. However, at the present time there is a certain oil company which also has a water treatment plant where they are working on the waste oil, and it might be possible to reclaim the amount of oil we get and use it for lubrication. It is possible to reclaim approximately 80,000 gals a year.

As far as the scale is concerned, I mentioned that it could be used for blast furnaces, but at the present time it is too contaminated. When the system is complete, we will investigate the use of this waste.

A. M. Quinn: We are turning out the quality of water suitable to go back into the river and to satisfy State demands. The question I have in mind is for each and everyone of the authors and is, how much benefit are the plants themselves getting from the improved quality of the water for their plant use. Is this water reducing their maintenance costs in the plant? Are they getting better cooling by this better water, or are they reducing maintenance costs, etc.?

F. C. Schoen: I rather anticipated a few more questions, and so had some additional facts which may be of interest. But first, to answer questions.

Mr. Kovacs spoke about the oil skimmers and the reuse of oil. At the present time we are not making any attempt to recover any of the oil. Primarily what we are getting is a combination of greases, lubricating oils, gear shields and a general mixture—so much a mixture that even the oil reclamation companies do not want to haul it away.

At our specialties division, the big drive has been to dry up the leakage which is causing the oil to get on the waste water more than anything else. That saving of oil, in itself, will pay off dividends.

Mr. Quinn asked about the possible improvement of river water. We have noticed an improvement at the steel works, but I think it is due to the system that was put in, more than anything else.

Formerly, we were badly bothered at flood times. Now, since the water is going through the treatment process, before going to the mills, it has cut down a good many extra millwright hours for cleaning of screens, formerly necessary when river was flooding.

I thought it would be of interest to tell you of some of our checks taken in 1950 and again in 1951 of the river water, itself. The low that we found in river water in parts per million of suspended solids was around 21 parts per million and went to 119 at one point, with a 2-ft flood rise of the river. A little later in the year, this was I think along in late March, we had 19½ parts per million and a high of 39 parts per million. The 19½ figure was the low. We found in 1951 a low of 34, with a high of 132 parts per million. We have never found a test showing less than one part in a million of oil, with a high going to about 80 parts per million. That may have been because of our sampling points.

On our waste water returns we have found during the five main days of operation the waste water coming back to the plant—as high as 258 parts per million of suspended solids, with a low going to around 80. In the specialties division, the high has been in the neighborhood of 60 with a low of 43.

One of the most interesting things was at the coke plant—we are finding a high—well, not necessarily a high—but more a norm of 260 parts per million in the water going into the first sump on the cooling system, with the water leaving the clarifier dropping to 34 parts per million.

There are still final settlements as we get to the base of the cooling tower, but the 34 parts a million has given no trouble on the cooling.

I thought these few facts on the river and what we are getting in our waste water might be of general interest.

C. S. Cassels: The skimmer used in our installation is similar to one described in one of the other papers and consists of a horizontal pipe with a longitudinal slot. In each of the two 100-ft long chambers there is one skimmer placed about 30 ft from the entering end. Between the entrance end and the skimmer are located two baffles and the aeration tubes. Most of the oil in the waste water rises to the surface on the upstream side of the skimmer and is moved to it by the normal flow of the water. Some oil and scum collects on the surface downstream from the skimmer.

The flight conveyors in the tanks move with the direction of flow on the bottom of the tank and against the flow at the water level, dipping under the surface a short distance downstream from the skimmer. Thus, when the conveyor is operated, the floating oil and scum below the skimmer is moved upstream toward it. By turning the slot in the skimmer to the downstream side during the periods when the flight conveyor is in operation, it is possible to push most of the floating material into it.

The main difference between our sludge removal equipment and the other system described is that our conveyors drag the sludge to underwater hoppers from which it is removed by pumps to settling lagoons. As we are handling a mixture of sanitary sewage and sandstone mud from grinding operations our problem is naturally different from those systems in which the solids are mainly mill scale. As removed from the settling basin our sludge is about 95 per cent water. After settling time in the lagoons this liquid is drawn back into the entering end of the tank. The oil collected from the system is a mixture of many types and is not suitable for reuse.

We do not reuse the water after it has passed through the disposal system so its quality has no direct effect on our processes. Only as the condition of the river improves through action by all involved can we realize any direct benefit from the program.

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A SIMPLIFIED AUTOMATIC INGOT BUGGY

. . . . a step towards the automatic steel plant is described in the following paper . . . .

OPERATING REQUIREMENTS

By I. N. TULL

Electrical Superintendent

Republic Steel Corp.

Cleveland, Ohio

▲ THE large majority of steel plants having blooming mills rolling ingots transport those ingots from soaking pits to mills by means of motor driven buggies, sometimes called chariots, tilting or pot cars. In a few cases a form of locomotive is used. In other cases, principally with short runs and relatively low tonnages, no car is used, but the soaking pit cranes carry the ingots from pits to mill approach table.

To meet the varied layouts in different mills, the car has to deliver its cargo end-on or side-on, depending on whether the soaking pits are in line with the approach tables or at right angles. Again, depending on length of run and capacity tonnage, the cars may be required to accelerate to a moderate running speed or may have to accelerate rapidly to a fairly high speed. These speeds have been on the order of 400 to 800 fpm.

Ingot sizes may vary in a given mill from 3½ tons to 15 tons; in other mills the ingots may weigh a great deal more. Not only do the weights vary, but also their shapes.

To meet the variations, buggies have been designed weighing from 10 to over 100 tons, and for moving the ingot from the buggy to approach table, many schemes have been used. Some have a few rollers geared to a motor to roll the ingot off. Others have rolls set on an incline to allow the ingot to roll off by gravity when a catch releases it. Still others have pusher mechanisms mounted on the car to push the ingots off; some of these can allow the ingot to go either top or butt first, at will of the operator. However, these mechanized cars are really large pieces of equipment. Some of them reach a length of 35 ft, with a track spread of 10 ft, and the weights are on the order of a hundred tons.

For moderate size ingots, say from 5 to 15 tons, a dumping cradle car is often used. Usually end dumping of the ingot from such a design is accomplished by pivoted arms on the car engaging cam shaped rails at the dumping terminal.

Figure 1 — Buggy is shown traveling towards the mill with a 12-ton ingot in the cradle.

To function properly and safely, this dumping mechanism must be made to work smoothly but positively. It is very difficult to accomplish this by means of non-automatic controls in the hands of a bored operator, particularly when the buggy is of a traction drive design. After ramming into the approach table at too high speed a few times, with the usual wreckage accomplished, the operator then makes the approach to the table so slowly as to keep the mill waiting for steel.

No auxiliary on a blooming mill should hold up that mill from being "full of steel" continuously. The work tables, screwdown, side guards and fingers should all be fast enough to keep out of each other's way. If the ingot buggy's delivery of steel to the mill is not frequent enough, it holds the mill back, just as lack of synchronizing the rest of the auxiliaries holds it back.

The expansion of the Cleveland District of Republic Steel Corporation required replacement of a number of soaking pits to meet the increased tonnage to be rolled on existing 32 and 44 in. blooming mills. Prior to

Figure 2 — Indicating lights are located above the push buttons in the operator's control pulpit.

these replacements, each mill was served directly by its own ingot buggy. The 44 in. mill buggy was directly in line with its approach table, the track running nearly full length of the pits, while the 32 in. mill buggy track was on the opposite side of the pits and only long enough to enter the pit building, the cranes carrying ingots from pits remote from the buggy.

With the new layout, there was no room available where the 44 in. buggy track had been, and a new buggy had to be operated on the opposite side of the pits and serve a common approach table serving both mills.

Ingots for the 32 in. mill proceed directly to that mill, while those for the 44 in. mill have to be transferred by means of a soaking pit type of crane from the common approach table to the 44 in. mill approach table. This type of crane allows rotation of the ingot in order that top or butt end may be entered for the first pass in the mill.

At the Steelton plant of Bethlehem Steel, a very splendid example of a buggy combining dumping either way to the mill, as well as good automatic control was described in a paper by Mr. S. H. Mumma and published in 1949 Proceedings AISE, p 699. Due to variations in shape and weights of our ingots, and lack of clearances, it was impossible to incorporate the design of the Steelton buggy in our design.

To meet the requirements of the two mills at Cleveland, it is necessary for the buggy to make a round trip from the pit furnace farthest away from the mills, in 58 seconds. This distance is approximately 350 ft, and within 10 seconds acceleration and deceleration requires a top running speed of 1200 fpm. At closer stations it is not necessary to reach such a high speed, and the control is designed to take advantage of this point.

For a traction drive buggy, in order to accelerate rapidly the weight on drivers must be sufficient to prevent wheel slippage, and a great deal of study was spent on this problem. The net result was a cable pulled buggy, as light in weight and as strong as possible, so that acceleration forces could be reasonable and yet the buggy substantial. This buggy has an approximate weight of 15 tons.

More than the traction problem, were the usual conductor bar problems of location, damage from heat and from cranes. Ward-Leonard control was provided for smooth acceleration and for automatic spotting of the buggy at its numerous loading stations accurately and quickly. The operation is very similar to that of an automatic elevator.

The loading stations opposite the pit furnaces have hoppers receiving scale and scrap falling from the ingots. These hoppers lead to the basement below and deliver scale into boxes which are removed by fork trucks for disposal to railroad cars.

We were much concerned with the problem of rope maintenance due to its location between the rails of the buggy and subject to the heat of hot scale and scrap, and occasional ingots falling on the rope. However, at Steelton the record was very good and the advantages of the rope hauled against traction are preponderant. We have had several cables to replace in the past year, mostly from dropped ingots, and some from hot scrap lying on the rope. These troubles are declining with experience, and with more appreciation by cranemen and operators on how much easier their jobs are, if the buggy is not out of service from rope damage.

The original design of the control contemplated geared travelling nut limit switches. These for forward and reverse directions resulted in a cumbersome switch. Before starting manufacture of the control, however, Mr. Fogely, brought in the finally accepted solution in the form of a dial rheostat positioning control, the functioning of which he will describe to you.

As stated earlier, the buggy is running at a top speed of 1200 fpm. This is established by the voltage of the generator supplying the buggy motor. There is leeway to increase this speed considerably, but the buggy has no trouble in supplying the mills. If the mills increase their ability to require more ingots, this buggy under its simplified and very practical control, will meet the call.

Figure 3 — Dial rheostat at left is geared to the winch and controls acceleration, deceleration and stopping. The controller shown at the right provides backup protection for speeds and overtravel. Guards have been removed from both units for photographing purposes.

ELECTRICAL SYSTEM

By HUGH S. FEGELY

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Three fundamental considerations are involved in the design of the electrical system, to adequately move the ingot buggy as described in the previous mechanical portion of this paper.

1. The system must cause the buggy to accelerate and decelerate in such a manner as to make the round trip time of the buggy a minimum.
2. The system must provide smooth acceleration and deceleration and limit the maximum tension in the cable at all times.
3. The system must operate in a fully automatic manner and include accurate positioning of the buggy at each of nine stopping positions.

In order to consume a minimum amount of time, the buggy must accelerate at the fastest possible rate consistent with the allowable cable tension, to such a speed either determined by the maximum allowable buggy speed, or to some portion of this maximum speed as determined by the rate of acceleration before the deceleration cycle begins.

A voltage regulating rotating control and a current limit rotating control provide adequate control for the generator voltage to meet the necessary operating requirements. The voltage regulating supplies excitation to the generator shunt field and thus determines the maximum speed of the buggy by limiting the maximum voltage applied to the motor. The maximum applied motor voltage is automatically selected by the control system, depending on how far the buggy has to travel to its stopping position.

The current limit control is always connected so as to exert its influence over the voltage regulating control. Any time that the motor armature current exceeds 100 per cent of rated value either in a motoring or regenerating direction, the generator voltage is modified to either decrease or increase its voltage respectively, so as to maintain 100 per cent motor armature current.

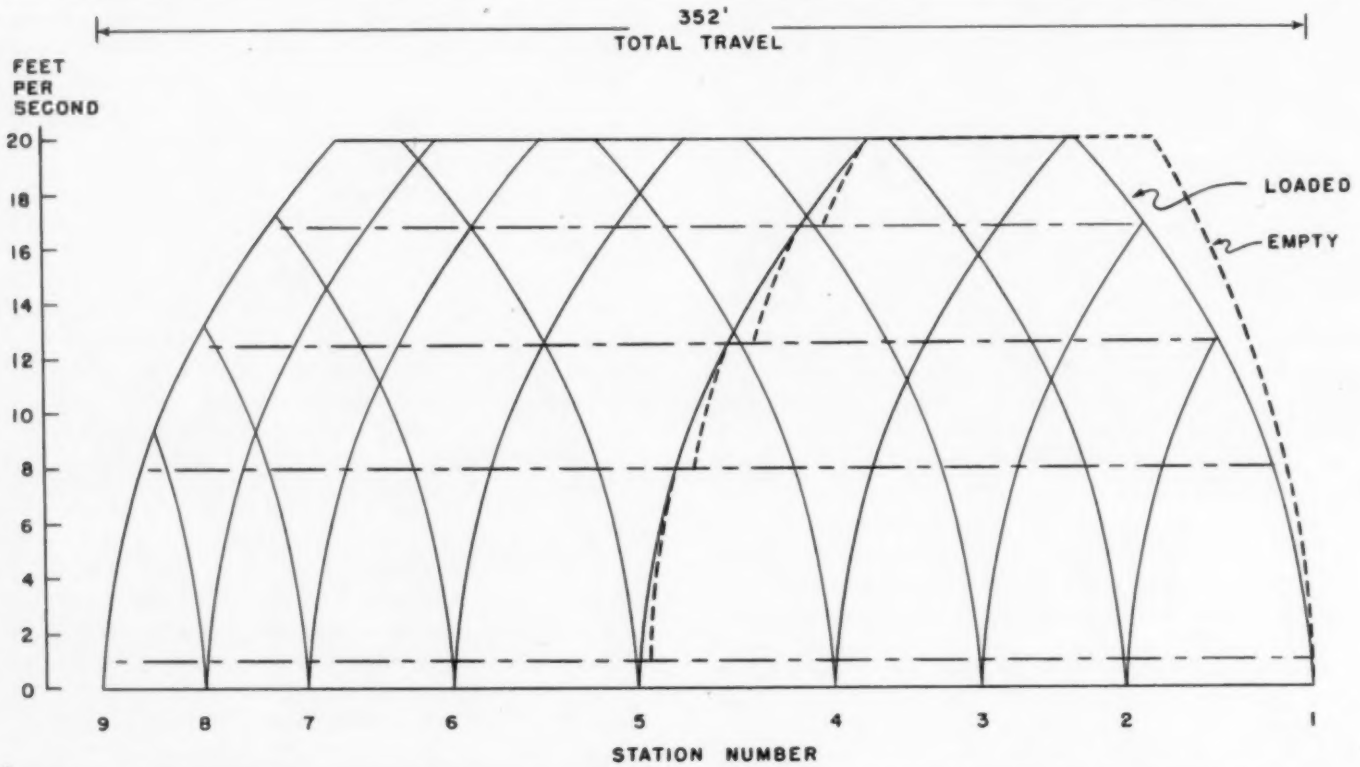

Figure 1 — Curve shows theoretical acceleration and deceleration which can be obtained with the mechanical system shown in Table I.

It is recognized that most of the power requirements are used for acceleration and deceleration. Final results show that only a per cent of the available hp is required to move the buggy at constant speed. In order to keep the cable tension within specified limits, calculations indicate that the armature current of the 200-hp driving motor must be limited normally to 100 per cent. In keeping with these limitations, and realizing that the inertia of the loaded ingot buggy is quite large, it becomes apparent that the generator voltage regulating system must include some element for limiting motor armature current.

It is advisable to keep the operator's control devices as simple as possible. By providing a fully automatic system, the operator needs to be provided with only nine pushbuttons, one for each position at which the buggy may stop. It is also advisable to be able to change the selection at any time regardless of the buggy speed or location.

Figure 1 indicates the theoretical acceleration and deceleration obtainable with the mechanical system shown in Table I. These curves are plotted with the actual distance between positions drawn to scale. Note that the stopping positions are unequally spaced. Time constants of the various machines and mechanical friction will modify these curves somewhat, but they do represent the principals involved in this control scheme so as to lead to the proper understanding. The difference in acceleration with a loaded or unloaded buggy may be noted in these curves. The two rotating controls inherently provide the desired acceleration and deceleration characteristics.

Accurate, automatic positioning without wasting time due either to unnecessary slowdown or overshooting, is accomplished by predicting in advance, the deceleration that will take place. By correlating a known rate of deceleration with the buggy position, the buggy speed may be controlled to decelerate to a slow speed just as it reaches the stopping zone.

Figure II shows a schematic diagram sufficiently complete to represent the basic features of this control. Such details as braking, motor field protection, jogging, emergency operation and auxiliary relaying are omitted for sake of simplification.

The most important part of the control portion of this diagram is the means of constantly interpreting, electrically, the distance between the buggy as it moves along the track, and the position to which it is going. By knowing the remaining distance and speed of the buggy, the deceleration is automatically started at the proper time to stop the buggy in the desired zone.

Since this is a cable driven buggy, the cable drum shaft is used to drive a rheostat through an appropriate gear box so that the rheostat travels over the greater portion of its allowable travel, corresponding to the complete travel of the buggy on its track. See Figure II. This rheostat is connected in a bridge circuit and becomes one of the two variable arms of the circuit. The other adjustable arm is a fixed resistor with taps which electrically correspond to the physical arrangement of the nine buggy stopping positions. The appropriate resistor tap is selected when the operator momentarily closes his pit pushbutton. Several polarized relays of adjustable sensitivity measure the amount and direction of unbalance in the bridge circuit. These relays, 1CR-2CR-3CR-4CR-5CR, indirectly established the strength of the rotating control pattern field and therefore determine the maximum speed of the buggy.

If for example, the buggy is going to be moved over a relatively short distance such that acceleration to 1200 fpm is not possible in order to stop at the desired location, the sensitive relays react to the smaller degree of bridge unbalance and thus apply a pattern field to the rotating control which is somewhat proportional to the distance to be traveled.

In this application it is found that a total of five steps of pattern field will adequately cover all combinations of movements of the buggy. The specific values of pattern field strength are selected on the basis of the acceleration curves given in Figure I. Proper selection of these values will make it possible to cause the buggy to continue to accelerate in speed until deceleration must begin, thus providing for the shortest running time between any two stopping positions. The step action on deceleration occurs because deceleration of the empty buggy takes place at a faster rate than with the loaded buggy. This causes the buggy to reach its next lower speed before it has reached the position where the next speed relay drops out. This action prevents deceleration to a creeping speed long before reaching its final stopping position.

Accuracy of stopping is consistently within a zone two feet long and most of the time the buggy always stops within a one foot zone. This is well within the physical requirements, since the scale hoppers are 14 ft long and scale may fall over a six ft length thus leaving eight ft zone in which to position the buggy.

The circuit containing the nine pushbuttons and the one normal stop pushbutton is arranged so that when any one pit pushbutton is momentarily pressed, a corresponding relay is picked up and sealed in. It may be noticed that if any other pushbutton is then pressed, the original relay is dropped out and the latter relay is energized and sealed in. This arrangement enables the operator to change his selection at any time. Green indicators corresponding to each pushbutton, light when a pushbutton is pressed, and remain lighted until the buggy reaches the desired postion.

The closing of the pushbutton relay connects the polarized relays to the proper tap on the fixed desistor so that the bridge is unbalanced in the direction corresponding to the direction of travel of the ingot buggy. By relays, the rotating control pattern field is energized in such a direction to cause the generator voltage to build up to properly move the ingot buggy. The movement of the ingot buggy turns the bridge rheostat in a direction to establish a balance in the bridge circuit. When the bridge is balanced, relay 1CR drops out and deenergizes the rotating control pattern field. At the same time, relay CT begins its timing action and in a few seconds opens the pushbutton circuit. This timing action is useful in case the buggy overshoots its designated position. Overshooting causes the bridge circuit

TABLE I

Mechanical data:

Weight of ingot	30,000 lb
Weight of ingot buggy	30,000 lb
Cable drum pitch diam	5 ft
Cable diam	1 in.
Motor-drum gear ratio	8.93/1
Driving motor	200 hp
Driving motor speed at 230 v	420 rpm
Driving motor speed at 400 v	679 rpm
Buggy maximum speed at 400 v	1200 fpm
or	20 fps

WK² of load components referred to motor shaft:

Motor brake	485
Motor armature	820
Motor coupling	300
Gearing	25
Drum coupling	15
Cable drum	460
Cable	40
Ingot buggy	2380
Total (unloaded)	4525 lb-ft²
Ingot	2380
Total (loaded)	6905 lb-ft²

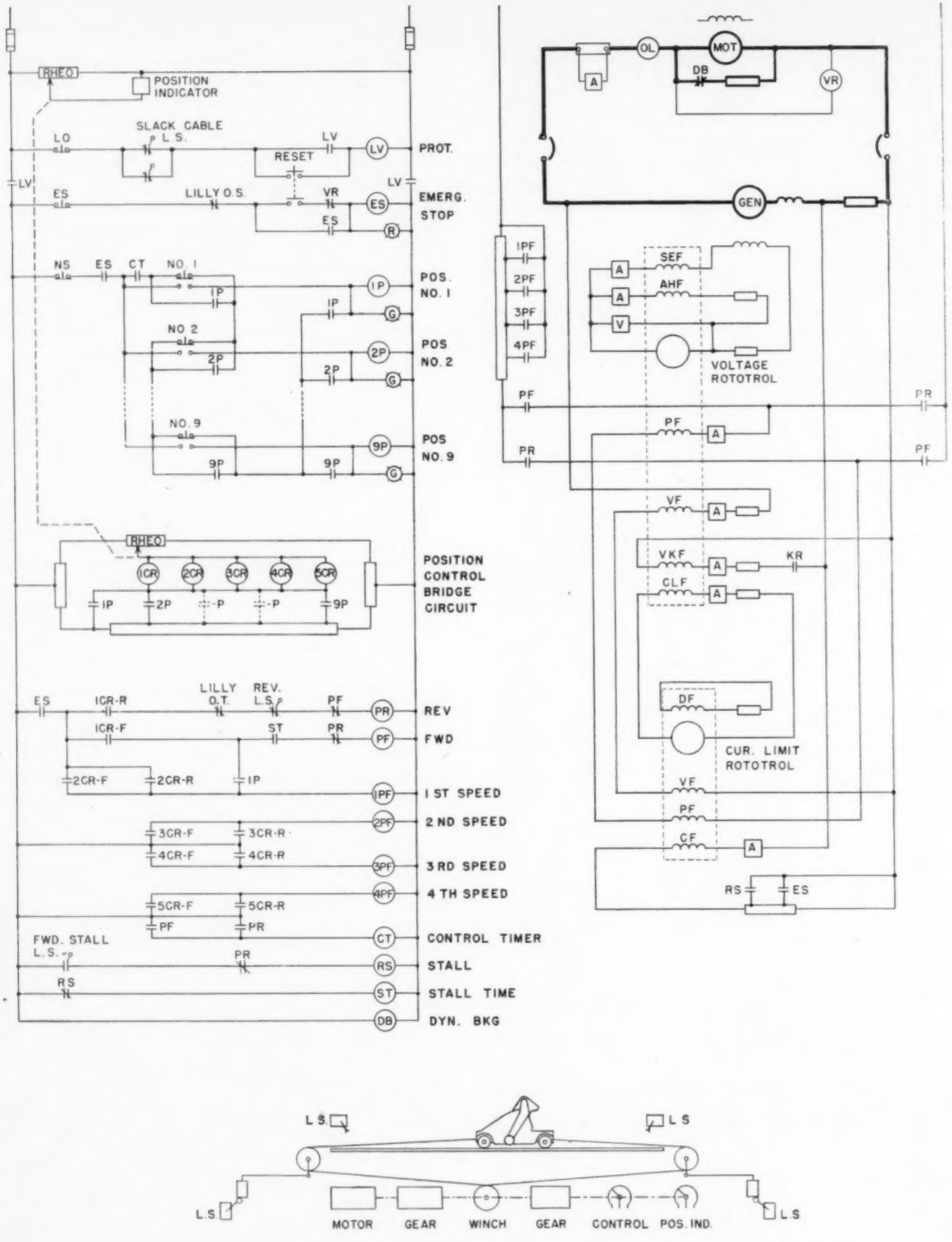

Figure 2 — Schematic diagram indicates basic features of ingot buggy control.

to become unbalanced in the opposite direction, and cause the buggy to reverse its motion to seek the proper balance. If the bridge circuit remains balanced for a few seconds continuously, the buggy must be properly positioned, and the control circuit is then permanently opened until the operator presses another pushbutton.

At the ingot receiving table, the buggy butts into stops on the end of the table. To assure that the buggy does not kick away from the table during the dumping cycle, the control is arranged to positively drive the buggy into the table at slow speed and stall in this position with reduced armature current limit for a few seconds. A track limit switch located at the approach table operates relays RS and ST to provide a timed stalled interval.

The one outstanding condition which is usually foremost in the design of any ingot buggy controller, is to incorporate features which will prevent a run-away buggy. The weight and speed of such a buggy make it apparent that a great deal of damage is possible if the buggy does get out of control. This hazard is doubly apparent in the case of the cable driven buggy. There is no braking system located on the buggy itself; any braking effort must be transmitted through the cable.

On this particular buggy, all possible precautions are taken to prevent or minimize failure due to any electrical cause. Electrically, this system inherently fails safe. As long as the main circuit breaker is closed and the main and rotating control motor-generator sets are running, emergency stopping allows more than normal regenerative current to flow to stop the buggy quickly. In the event that the circuit breaker opens, or either motor-generator set stops running, the absorption of regenerative power may be impossible. Under this condition, dynamic braking resistors are used to absorb this power.

A broken cable presents a very real hazard. In this respect a limit switch is located under each cable counterweight. Obviously, the normal operation of the buggy will cause the two counter-weights to operate these limit switches, but at no time will both counterweights be down simultaneously. If both counterweights do get down at the same time, it indicates either that there is an abnormal amount of slack in the cable, or the cable is broken. In either event it is highly desirable to stop the cable winch from any further movement. These two limit switches operate in the control circuit to prevent operation under these conditions.

Another effort for safe operation is provided by the use of a Lilly controller. This is a mechanical device very frequently used on hoists. The controller correlates the speed of the buggy in relation to its position on the track. Referring again to Figure I, the outside boundary of the curve indicates the maximum safe speed at any position of the buggy on its track. This type of program is cut into the cam on this controller, and a fly-ball governor provides a speed indication. If operating conditions indicate that the buggy is exceeding this program, a contact in the controller opens the control circuit.

This control system was put into operation in February, 1952 and has proved very satisfactory. The desired operating characteristics have been fulfilled, and maintenance has been no different than would be expected with any other type of control system. This simplified automatic ingot buggy controller with accurate positioning may well determine a new trend in the design of future ingot buggy systems.

APPENDIX

For a mathematical interpretation of the data involved in this application, the following accounts for the calculation of the curves shown on this paper:

WK^2 of ingot buggy

$$= \text{weight} \times \left(\frac{\text{maximum buggy fpm}}{2\pi \times \text{maximum motor rpm}} \right)^2$$

$$= 30{,}000 \times \left(\frac{1200}{2\pi \times 679} \right)^2$$

$$= 2390 \text{ lb-ft}^2$$

Torque developed by motor.

$$T = \frac{\text{hp} \times 5250}{\text{rpm}}$$

$$= \frac{200 \times 5250}{420} = 2500 \text{ lb-ft}$$

which will produce a cable tension of:

$$2500 \times \frac{8.93}{2.5} = 8930 \text{ lb}$$

Converting the load WK^2 to an equivalent weight acting at pitch diameter of the cable drum:

$$\text{Unloaded buggy} = 4525 \times \left(\frac{8.93}{2.5} \right)^2 = 57{,}700 \text{ lb}$$

$$\text{Loaded buggy} = 6905 \times \left(\frac{8.93}{2.5} \right)^2 = 88{,}200 \text{ lb}$$

Velocity-distance curves are a function of:

$$V^2 = 2 \times \frac{F}{M} \times S$$

where V = buggy speed in fps
F = applied force in lb
M = mass = equivalent weight/32.2 lb
S = distance in ft

In this application F and M are constant so the equation becomes:

$$\text{Unloaded buggy } V^2 = 2 \times \frac{8930 \times 32.2}{57700} \times S = 9.9\,S$$

$$\text{Loaded buggy } V^2 = 2 \times \frac{8930 \times 32.2}{88200} \times S = 6.49\,S$$

DISCUSSION

PRESENTED BY

D. C. McCRADY, Electrical Engineer, Steel Co. of Canada, Ltd., Hamilton, Canada

FRANK C. FENNELL, Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

SAMUEL H. MUMMA, Superintendent Electrical Department, Bethlehem Steel Co., Steelton, Pa.

JOHN D. LEITCH, Chief Engineer, Electric Controller & Manufacturing Co., Cleveland, Ohio

C. B. HUSTON, Commercial Engineer, General Electric Co., Schenectady, N. Y.

I. N. TULL, Electrical Superintendent, Republic Steel Corp., Cleveland, Ohio

HUGH S. FEGELY, Control Engineering Department, Westinghouse Electric Corp., Buffalo, N. Y.

D. C. McCrady: We have, at the Steel Company of Canada plant in Hamilton, just completed a similar study in connection with our 44 in. mill. In our case, all steel must pass through this mill, to be rolled into slabs directly, or on to a 34-in. blooming mill, which acts as the rougher for an 18-in. billet mill.

In our case, the original ingot buggy, in line with the tables, was of conventional design, except for narrow width, due to the small amount of space between our soaking pits and the control floor. With the increase of tonnage expected this next year when our new open hearths will be in operation, we too were concerned lest the ingot buggy be a limiting item in our blooming mill set up.

If the location of sheaves and propelling winch had been practical with our layout, most certainly we would have put in a similar arrangement to that which Mr. Tull has described. We did find that, requiring an acceleration rate of two mp hr sec, the wheel loading was such on the drivers that this rate was apparently practical. Consequently, we have purchased a Ward-Leonard control arrangement, with current limit acceleration. A rather specialized slowdown control is provided whereby the first slowdown, if not effective for some reason, causes a second slowdown limit switch to set the brakes if the rate of deceleration is not what it should be. In this way we are hoping to prevent collisions although I agree that a rope propelled vehicle is more fool-proof in this regard. Our top speed will be 900 fpm, with thermal ratings such that a trip can be made to and from pits, a distance of 350 ft, at a rate of 45 ingots per hour. This limitation has to do with the rolling of billets, whereas slab rolling in our case will not require as high a rate of ingot handling. Undoubtedly, if we had a schedule of over 60 ingots per hour, which was Mr. Tull's requirement at Republic Steel Corporation to handle their two mills, we should have resorted to a cable-drawn buggy, no matter what the complication regarding location of sheaves and so on.

Mechanically and electrically, a cable-operated machine does appear to be a more logical solution to the problem, where such an installation can be worked in.

Frank C. Fennell: The control system described by Mr. Fegely can also be used with the traction-type of ingot buggy where the motor is mounted on the buggy carriage. Figure 1 shows the basic features of such a system.

The buttons around the periphery of the rheostat Mr. Fegely showed you are replaced in this system with sections of a control rail, and the movable arm on the rheostat is represented by the collector shoe which moves with the buggy along the track. The accuracy of the system is determined by the number and length of the rail sections. Mr. Fegely mentioned that the rheostat had 240 points, and to obtain the same degree of accuracy on the traction buggy, would require a sectionalized rail with 240 sections which obviously is not practical. In the usual case one or two rail sections are used for each soaking pit position.

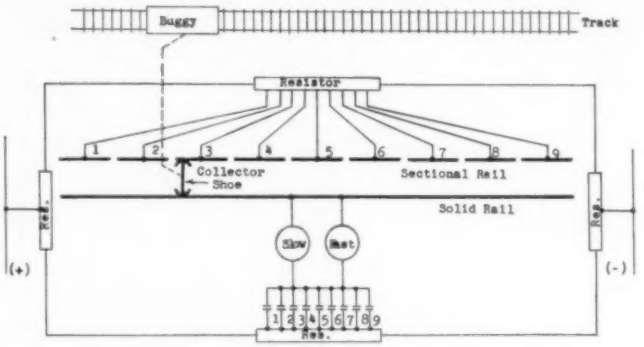

Figure 1 — This scheme shows control system where motor is mounted on the buggy carriage.

Automatic positioning systems using sectionalized rails to operate relays have been used on traction type buggies for some years with good success, particularly where only a slowdown and stop are required at either end of the track. When such a system is expanded to provide a stopping position at each soaking pit, it becomes difficult to make a "fail-safe" control—one that stops the buggy in case the collector shoe drops off the rail. It is this "fail-safe" feature that makes Mr. Fegely's bridge circuit so valuable for traction buggies. If a shoe drops off the sectionalized rail, the system acts as though the bridge were balanced because no voltage appears across the relay coil, and the buggy stops. The importance of this feature cannot be overemphasized when we consider the number of accidents that have happened to this type of buggy.

A rather novel variation of the basic bridge circuit for traction buggies will soon be in operation. In this system, resistors and associated sectionalized rails make up both sides of the bridge. The variable element of one side is a collector shoe mounted on the soaking pit crane, and on the other is the collector shoe of the ingot buggy. Movement of the pit crane unbalances the bridge and a rebalance is obtained only when the buggy is moved into position opposite the crane. With this control arrangement, the buggy always seeks the pit crane and stops in front of it after taking an ingot to the receiving table.

Samuel H. Mumma: We have had a buggy of this type in service at the Steelton plant since 1947 and it is still working very well. We think the big advantage

in the cable-driven buggy is the light weight of the buggy to handle the job. Our buggy weighs 15 tons and it handles ingots from 5 to 7 tons. We have had very little trouble with the cables; of course, once in a while an ingot drops and damages one, but the normal life of a cable is from 8 to 9 months if you have no bad luck. In our operation it is necessary to dump the ingot either way. Sometimes top first, and other times bottom first. This is taken care of by the cams at the end of the travel. The craneman leans the ingot the way he wants it to drop on the roll. The only other parts we have changed on the buggy are a few bearings. The scale from the ingots is caught in a pan at the bottom of the buggy when the ingot is dropped in the hopper. This scale is dumped into a box at the end of the travel when the ingot is dumped on the roll table.

The control is very simple compared to this new buggy and, of course, is not as selective. Our buggy runs at one speed on all length of trips which is about 800 fpm. The acceleration and deceleration is handled by a neon tube timer. All the stops, slowdowns, and final limits, are taken care of by a traveling nut limit switch. We have no special operator for the buggy. The pit craneman operates the buggy. He opens the covers, picks out the ingot, and puts it in the buggy and then starts it up to the rolls. The buggy runs up to the rolls, slows down and dumps automatically, and then remains stationary until it is brought back by the pit craneman. There are four stopping positions along the pits, and the buggy will stop at the position where the crane is located. This is accomplished by sectionalized contact rails. The craneman, at any time, can inch the buggy either way, and can stop it at any position along the run.

There is only one question I thought of asking, that is, have you any excessive wear on the field rheostats? We thought of using this scheme for accelerating and decelerating, but were afraid the wear would be excessive on such a constant service.

John D. Leitch: We are working on a very similar problem at the present time. This too, is an ingot buggy driven by drums and cables. Two motors are used, one at each end of the runway. The buggy is pulled in one direction by one motor and in the other direction by the second motor, there being no return-cable below the tracks as in the case discussed today.

The ingot buggy described by Mr. Mumma at Steelton is one on which we furnished the control. It is not nearly so complicated as that you heard about today but as far as I know, has proved very satisfactory in its performance.

C. B. Huston: We have had, in the past, ingot buggies of all descriptions and we all know the manufacturers as well as the operating people, what difficulties have been experienced and what hazards there are in the operation of the equipment. When these mechanical features are shaken down to the bare minimum, such as is very evident in this cable-drawn buggy, then the electrical manufacturer has a free hand of disclosing his ingenuity in controlling the equipment. When these problems are put squarely to the electrical manufacturers, they usually come forward with the results.

I. N. Tull: Mr. Mumma asked about the wear on those controlling dial rheostats. There has been no wear so far at the end of eight months' operation. I might say that we have ordered some spares, including those dial rheostats, in case they do wear or something happens to them.

Mr. McCrady mentioned the difficulty of the return rope which he could not put in the basement on account of interferences.

Mr. Fegely will tell you how that problem has been solved, and Mr. Leitch indicated that he is working on a similar job with the same means of solving that problem.

Hugh S. Fegely: Regarding Mr. McCrady's problem of finding space for the winch and the return cable, this problem has been solved by using a separately driven winch at each end of the buggy travel. We will soon put such a design into operation. Tension in the trailing cable (which may be on either end depending on the direction of buggy travel) is automatically maintained by current regulators. With such a setup, the central winch room and the return cable is not required.

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A NEW MAINTENANCE TOOL FOR STEEL MILL USE

By J. J. BARRY
Hardfacing Specialist
Air Reduction Co.
New York, N. Y.

. . . . this welding process is particularly applicable where high heat conductivity would ordinarily require an elaborate welding technique, when speed is essential, or when work must be done on a volume basis . . . .

▲ ALTHOUGH efficient maintenance operations are essential to the economy and uninterrupted production of big and small business everywhere, the modern steel mill is probably the one industry that can least afford to ignore or neglect the effective and economical use of the most modern tools and processes.

Steel mills use equipment that is heavy and massive, yet subject to such wear and tear that maintenance is a repetitive, demanding job conducted on a scale that is unequalled anywhere for sheer variety and volume of parts, tools, equipment and apparatus.

To keep steel production going at, or above, rated capacity while practicing maximum economy, steel mill management has employed, and is using, every effective tool and process in the arsenal of standard maintenance techniques. Moreover, steel mills have gained reputations as "proving grounds" for new processes and products because of the scope they offer for applications and because they stand ready to incorporate the newest and latest money-saving tools into their production plans.

In general, the maintenance work falls into two categories as far as welding operations are concerned: (1) the emergency repair of such parts as broken engine bases, frames, mill housings, presses and other heavy castings, and (2) the constantly recurring repair of such parts as coupling boxes, guides, rolls, buckets, chutes, and other parts used in large numbers and under such severe conditions as to require frequent replacement.

Probably the largest single maintenance task in steel mills, and certainly the largest single use of welding, is found in the second type of repair. This type of repair involves the restoration of worn parts. Parts may be rebuilt to size, hard-faced to ward off further wear, soft-faced to prevent the wearing of the work or a mating part. They may be reinforced, lengthened or otherwise modified if required. Many repairs are actually improvements. Many others consist completely, or almost completely, of new parts. All of them are centered around either weld-fabricated or weld-deposited new material.

THE WELDING PROCESS

Conceived primarily as a production type tool, this welding process is currently headed toward uses which will carry it considerably beyond the important areas of its original applications.

Since the first production successes of this process on heavy structural aluminum and work of a direct fabricating nature, it has become increasingly clear that this new welding process—which we shall describe in detail—has a maintenance potential that is gradually becoming an actuality in many important manufacturing centers.

Steel mill maintenance, for example, is a highly competitive area where entrenched standard practices will not be dislodged unless a new process proves its fast, quality-giving, money-saving capacities on build-up and overlay work with ferrous and non-ferrous alloys.

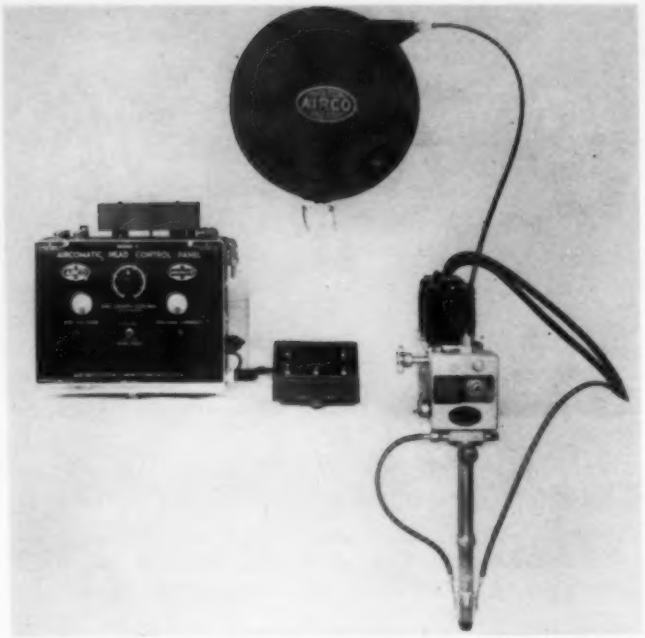


Figure 1 — Basic equipment for automatic applications of the process. Units included are the head, wire reel, control panel, and remote control box.

While there is considerable commercial data which demonstrates the effective maintenance value of this welding in steel mill use, this current phase of the development of the process has the character of a campaign as much as an accomplishment. Maintenance uses for this process are, then, part of a proposition that needs assistance—not resistance—if mutual benefits are to accrue to both sellers and users of this process.

This is an arcwelding process. It embraces not only some of the desirable characteristics of both ordinary electric arc and non-consumable electrode inert-gas-shielded welding but offers certain combined features which distinguish it as a new and unique welding tool designed for speed and quality of weld results.

This process employs a continuously-fed bare-wire electrode operating within an inert gas shield which protects the weld metal. The electrode is a bare wire in coil form which carries heavy currents on a relatively small diameter wire, providing high current density. The composition of the electrode may be varied to meet job requirements.

The shielding gas protects the weld metal from the various active elements in the atmosphere which would otherwise combine with the weld metal and create oxides, gas porosity, and other undesirable results. An important feature of the inert gas shield as a method of weld protection is that the arc and weld pool are constantly visible. Good visibility provides good control for the operator, reducing the risk of unsatisfactory welding. The gas also protects the heated electrode so that high current densities can be employed without making the electrode too hot.

The speed and quality of weld results obtained with the process are conveniently involved with each other; haste, in this particular case, by no means makes waste. Rather, it accounts for maximum production efficiency. For example, the high current densities provide: (1) the high deposition rates which mean high speed welding, (2) the spray-type metal transfer in the arc which is important for vertical and overhead position welding, and (3) excellent penetration which can be controlled and made variable. Speed also means less time-exposure to heat. This makes it possible to restrict the heat-affected zones and to minimize undesirable heat effects such as distortion, carbide precipitation and resultant poor corrosion resistance when these factors are problems confronting the welding operator.

Moreover, the reversed-polarity direct current used for the process permits the welding of such metals as aluminum and stainless steels without the fluxes usually required for other methods. The stubborn oxide films characteristic of such materials are broken up and "lifted" electrically with this type of current. Elimination of fluxes and slag adds appreciably to the speed and efficiency of the operation.

Metal transfer in the inert-gas-shielded metal arc is very efficient. Chemical analyses of the electrode wire and deposited pads of undiluted weld metal are practically identical for all the common metals and alloys. Even the very active element titanium which is easily oxidized (and fails to transfer across the arc of the conventional stick electrode) may be recovered in the weld with good efficiency when present as an alloying element in the electrode wire.

The arc is self-regulating; that is, the wire automatically burns back to maintain proper arc length without the operator having to continuously adjust the electrode's distance from the work. This means the operator does not have to worry about arc length and can devote his attention to the weld puddle itself.

Applied either manually with a gun for welding in all positions, or automatically with a head for flat and horizontal fillet welding, this process can be used with helium and argon or mixtures of both gases. In this process the arc is shielded by a stream of inert gas which issues from a nozzle through which the electrode passes. Wire and shielding gas are carried through a flexible hose to the gun or automatic head, depending on which is used.

The manual equipment, then, consists essentially of a wire-feed unit, delivering the electrode wire through a gun. Welding current is supplied by a conventional

Figure 2 — Adaptable to steel mill maintenance work, this manual gun is designed for heavy currents and high duty cycles.

d-c generator. The automatic machine equipment is an easily-operated, light and compact unit, with a simple control circuit. Both types of equipment are adaptable to handle various sizes and types of electrode wire.

Here, to recapitulate, are some of the distinct advantages offered by this process: (1) a manual welding process with the essential features of automatic welding, (2) continuous deposition of filler metal at high rates, (3) manual manipulation of an automatic process for welding in a vertical and overhead position, (4) high quality weld metal deposits, (5) minimum edge preparation owing to deep penetration, (6) ability to weld heavy sections with little or no preheat, (7) no flux required, slag removal eliminated, and (8) visible arc, no blind welding.

Figure 3 — Overlaying inner surface of cast iron flange bushing with aluminum bronze.

GENERAL APPLICATIONS

If necessity is the mother of invention, and if any single industrial need can be said to have brought this process into being, then it was primarily the need for an effective production method of welding heavy sections of aluminum that gave birth to this process. Excellent welding results on heavy sections of aluminum represent the first major commercial success of the process.

Since 1948 it has moved forward methodically into stainless steels, nickel and stainless clads, copper and copper base alloys and other hard-to-weld metals where quality of weld results is critical. The current position of the process is based largely on its performance with the above metals.

Without getting into any specific commercial jobs for the moment—of which there are many—and without discussing any of the finer points involved in appropriate technical procedures for particular applications, here is a brief survey of what the process has done in a general way; later, we intend to speculate a little on its future bearing in mind that the full effect of an efficient welding process in a highly-mechanized society is really a never-ending phenomenon that goes, ultimately, beyond the expectations of the men involved in working out its design, its production, its promotion, and its original commercial applications.

Figure 4 — Close-up of bushing (for a centrifugal casting machine) shows overlay partly completed. Aluminum bronze wire was used for two layers to complete the job.

ALUMINUM

All weldable aluminum alloys are suited to such welding. Of the wrought materials, 2S, 3S, 4S, 52S and 61S are satisfactorily welded. The thickness range begins around $\frac{1}{8}$ in. with no practical upper limit. Although this process readily adapts itself to certain problems in lighter gauge aluminum, it is recommended primarily for aluminum welding of $\frac{3}{16}$ in. and thicker. The high deposition rates of this process, while using the inert-gas-shield and breaking up the oxides electrically, solve the problem of fast, economical, high-quality welds in heavy aluminum.

STAINLESS STEEL

While it will take some time before all the analyses of stainless steel in electrode wires for the process will be available, there is a proven production process for

Figure 5 — Stainless steel is being welded by the process.

the welding of stainless steel in those austenitic (chrome-nickel) analyses for which wires are available. All the commercial austenitic type stainless steels—1/8-in. plate and heavier—can be welded by this process.

One of the specific advantages of this process in welding stainless steel is the small loss of alloying elements when the filler metal is carried across the arc and deposited in the weld. The ability to deposit weld metal of identical composition as the electrode wire used permits joints to be made in which both the weld and plate material have the same chemical composition, thereby minimizing corrosion and expansion problems where these factors are important.

The process also deposits stainless steel at a high rate with a given welding current and hence minimizes heat effects in the base metal. The welds are sound, without porosity or slag inclusion.

Admittedly, some jobs are so set up and designed that this welding cannot yet compete on a cost basis, with other methods. This is true of any new process making its way. Stainless stick electrodes *do* represent an efficient and economical method of welding stainless steel in many cases. But a lot of work is being done; some of it is under the most rigid kind of government security restrictions and the process is satisfying the most critical standards.

NICKEL AND STAINLESS CLAD STEELS

There are many reasons for using clad steels and undoubtedly the most important is that they are less expensive than the solid cladding metal, and yet have the same corrosion resistant properties. It is, therefore, important that the welds on the clad metal side have the same corrosion resistance as the cladding metal.

Procedures have been developed for the welding of nickel and stainless clads. The basic problem in welding clad materials is to hold down the iron dilution of corrosion-resistant cladding to a level where it does not seriously effect corrosion resistance.

Control of dilution is largely a function of weld penetration. This process provides not only deep penetration but well-controlled variable penetration, making it possible to hold the dilution well under allowable limits.

Experiments are planned to determine the maximum plate thickness that can be successfully welded in both nickel and stainless clad steels by the process.

COPPER

Copper is a widely used metal but it has never been a natural for welding. The metal has a high heat conductivity which makes input of heat a serious problem. It requires fluxes to permit quality welds by most older methods, and it suffers from certain undesirable heat effects when improperly heated and cooled.

All these problems have been overcome in one method by this process. Copper in the thickness range of 1/8-in. up to 1 in. and more has been welded with marked success for any purpose for which welded copper is suitable.

COPPER-BASE ALLOYS

Some of the copper-base alloys offer fewer problems with this process than any of the other metals so far attempted. Aluminum and silicon bronzes in particular are welded satisfactorily over the whole welding range and under all conditions.

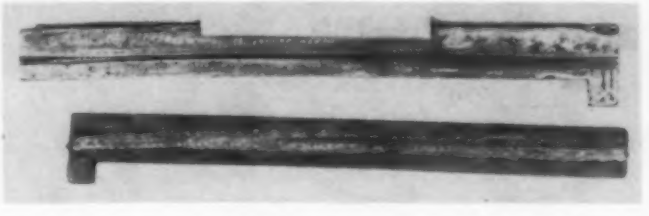
Overlays of aluminum bronze on dissimilar metals such as steel, copper, cast iron, and manganese bronze are effectively made. These overlays are semi-hard, durable, corrosion resistant. Various metals have been surfaced with welded overlays suitable for bearing purposes, including mild steel, gray cast iron, deoxidized copper, naval brass, etc.

Figure 6 — Operator is welding a phosphor-tin bronze mill guide. The 19 in. of weld are finished in less than two minutes, but the time figure varies with condition of the guide and depth of worn area.

The application of this welding to silicon bronze has been successful both in trial and full-scale production work. While savings in this application have not been fully explored, it is obvious that welding copper silicon at travel speeds such as 180 feet per hour is a great deal faster than any other method, and since the welds are of excellent quality and require no particular finishing or clean-up measures, the savings are sizable.

Among the major copper-base alloys in common use which are readily welded by this process are phosphor-tin-bronze and leaded phos-tin-bronze. The ones with serious weldability restrictions are the high-zinc brasses and manganese bronze. The chief restriction here is that these materials cannot be used as electrode wires, because of the vaporization of the zinc content. They can be welded, however, as base metals with aluminum bronze electrode wire and a careful backhand technique with low current on the first pass.

Figure 7 — Steel mill guides, of phosphor tin bronze, before and after weld buildup.



APPLICATIONS IN STEEL MILL MAINTENANCE

One of the most important applications for the process in steel mill maintenance is its use for rebuilding steel sheet mill guides. These guides require a soft build-up, yet one which will have reasonable durability. The base metal of the guides varies considerably in its analysis, but is generally a leaded phosphor-tin-bronze which can be rebuilt with either a similar type of phosphor bronze or aluminum bronze.

Sheet mill guides are a steadily recurrent maintenance problem in steel mills. They have a service life between repairs, sometimes of only a few hours, and their repair has been a difficult job because of the preheat required to weld them by other methods.

The stick electrode method has required chipping and grinding and much finishing work. The results have been only passable, yet because of the value of aluminum bronze as a semi-hard, durable and corrosion-resistant overlay, it has been used consistently and in great quantity.

With this process—which is already in considerable use for this work—aluminum bronze goes down fast, smoothly, in a dense, clean, relatively flat deposit requiring a minimum of finishing. The only preparation usually required is thorough cleaning, such as vapor degreasing. Welding is fast with no apparent distortion.

By elimination of the preheat and the elaborate preparation measures necessary for other methods, and because of the high speed welding and the minimum finishing required, this process can effect impressive economies for maintenance engineers in this operation.

Phos-tin-bronzes are also used for overlay work on brass and bronze steel mill rolling guides, such as those used in sheet and strip mills. The first conclusive field tests of sample units rebuilt with phos-tin-bronzes, using the process, showed a service life three to four times that of a new guide, without any operating difficulties. An increasing amount of maintenance use is being made of the process on this particular application.

Similar uses for phos-tin-bronzes on bearings, pads—or any job where properties of the alloys can be used to advantage and where the volume of the work justifies it—provide excellent applications for the process and equipment.

It is obvious from the foregoing that some of the most interesting advances made by this process are taking place in the field of overlay work. Not only is this type of application becoming an accepted maintenance operation in the deposition of bronzes, but it is extending to the use of stainless steel for such special purposes as valve stems, seats, and crane brake wheels. In general, these overlays in stainless are practical, if not actually indispensable, wherever critical standards in stainless deposits have to be satisfied on a volume, repetitive basis. Even work that is more of a "unit" character, such as water wheels in hydro-electric power plants in direct support of steel mill operations, provides an excellent opportunity for this process to demonstrate its capacity to meet extremely critical requirements related to complex corrosion and erosion factors.

While the probable advances for the process in stainless overlay work for steel mill operations are largely speculative at the present time, they will depend to a considerable extent on the following factors: (1) recognition of the ability of the process to transfer with excellent efficiency all the alloying elements in the wire to the deposit, (2) recognition that the control of base metal dilution can be held to less than five per cent with this process, and (3) the increasing use of composite parts where a cheaper steel provides the basic structure and corrosion resistance is needed only in localized areas.

The deposition of stainless steel overlays on mild steel castings or forgings offers definite possibilities for the extended use of the process in a variety of applications. One job, already standard, involves the creation of three circumferential bands of stainless steel on a steel casting over 30 in. in diameter, which provides all the corrosion resistance required at an immense saving over a stainless casting throughout.

Another good reason for the success of this welding on stainless materials in general is the freedom from slag and flux, the elimination of interpass cleaning, and assurance that the weld will be free of inclusions which may weaken either its strength or corrosion resistance.

Elsewhere in steel mill maintenance, applications for

Figure 8 — Gun is being used to rebuild a cast copper tuyere.

Figure 9 — Illustration shows finished weld on cast copper tuyere.

this process which promise to become standard practice are being carried out on copper tuyere cooler repairs. In this troublesome job, previously done with preheating and gas welding, the process has given indication that it will be an excellent tool for fast and simple repairs.

FUTURE OF THE PROCESS

Mass repairs are being carried out in steel mill maintenance which involve parts whose analysis has not yet been matched by wire electrodes of comparable analysis for the process. Spindles, crabs, and coupling boxes, for example, are made of a number of analyses of steel which is subjected to extremely severe service. These items of steel mill rolling equipment require recurrent buildup of as much as 1½ in. of worn-away material, and involve elaborate welding procedures which, though effective, stand in need of simplification and improvement.

Steel electrode wires for the process to meet the analysis requirements of a wide range of carbon steel products and parts represent a metallurgical production problem that has been under investigation and is being successfully worked out, particularly in mild steels.

The chief obstacle has been the difficulty of getting a bare wire analysis with sufficient welding latitude to make its applicability as general, and its production as economical, as the stick electrode core wires whose latitude of application is extended by alloying elements in the coating.

When bare steel electrode wires of various analyses are made available in quantity to back up this welding equipment, there will be some revolutionary extensions in the use of this process.

To put the matter conservatively, the future holds the promise of wider applications of the process in maintenance as well as fabricating operations. These are likely to be made: (1) wherever high heat conductivity of a metal requires an elaborate welding technique, (2) wherever practices are standard simply because there is no better welding technique available, (3) wherever speed is essential, (4) wherever critical standards of weld analysis must be met, and (5) wherever work is done on a volume, repetitive basis.

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DISCUSSION

PRESENTED BY

CHARLES S. SCHROEDER, Director of Engineering, Yale & Towne Manufacturing Co., Philadelphia, Pa.

J. J. BARRY, Hardfacing Specialist, Air Reduction Co., New York, N. Y.

Charles S. Schroeder: What is the advantage of welded frames for big trucks, which is a big element? They are always low carbon steel, but quality of welds is important. Would this process have an advantage over the usual coated rod?

J. J. Barry: The answer to that question generally is yes. The economics of the process as applied to steel, however, have not been worked out across the board as yet. The process is relatively new and the steel welding field is pretty wide. We can say that both laboratory work and tests in production work definitely indicate advantages over stick electrode welding on many applications, among which would be automotive frames.

As far as some of the aluminum trailers are concerned, and there are a great many aluminum trailers made in this country today, that is a very common and successful application. It is being done every day.

Charles S. Schroeder: How about high carbon steels, alloy steels, in thick sections?

J. J. Barry: On thick sections, yes. Usually the process is for sections ⅛-in. and thicker. You do not have too much success with the thinner sections, that is, less than ⅛ in. For that process there is the non-consumable shielded gas type of welding. There you use a tungsten electrode which is not consumed, and of course the same shielding gas. You can weld steel with that process, however.

AID DEFENSE

MORE SCRAP TODAY . . . .

MORE STEEL TOMORROW.

GET IN THE SCRAP TO KEEP STEEL COMING.

NON-FERROUS SCRAP IS NEEDED TOO!

RECOVERY OF TIN FROM SCRAP TINPLATE

By A. J. KROMBHOLZ
Assistant Head
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. . . . efforts by the steel industry to conserve critical materials are well exemplified by this plant built by Weirton Steel for the recovery of tin . . . .

▲ ALLOTMENT restrictions on the use of tin, combined with its high price and the unprecedented demand for scrap steel were deciding circumstances which led Weirton Steel Co. to consider establishing a detinning and tin recovery operation for the scrap produced in its tin mills. The need for such an operation was further enhanced by the fact that a high percentage of the scrap is in the form of wound edge trimmings produced in the shearing of electrolytic tinplate. The wound material had no market value as tinned scrap, and its high tin content, ranging from 10 to 20 lb of tin per ton, made it unsuitable for direct use as steel scrap.

To meet the demand for conserving tin and scrap, a simple alkaline detinning and tin recovery process was developed. The original work on this process was carried out in a small pilot plant with a capacity for treating about 400 lb of scrap per charge. This plant provided the basic engineering design and operating cost data which showed that a tin recovery operation could be made economically practicable.

The detinning plant at Weirton was designed to process 2500 tons of scrap per month if operated at 18 turns per week. Improvements in the efficiency of operation and in the equipment used in the process have greatly increased this potential detinning capacity.

The chemical principles on which the entire operation is based are generally well known. However, much of the equipment employed for handling and processing the scrap is original in design and may therefore be of some interest to those concerned with the subject of detinning scrap.

CHEMISTRY OF THE DETINNING PROCESS

Dissolving the tin — The chemistry of the process is relatively simple. Metallic tin will dissolve in a hot solution of sodium hydroxide to form soluble hydrated sodium stannate and gaseous hydrogen according to the reaction:

$$Sn+2NaOH+4H_2O \rightarrow Na_2SnO_3 \cdot 3H_2O+2H_2 \qquad (1)$$

The hydrogen liberated on the surface of the metal slows down the rate at which tin reacts with the alkali. To maintain a high rate of solution of the tin, it is necessary to remove the hydrogen as rapidly as it is formed. This can be done by means of an oxidizing agent such as sodium nitrate. In this reaction the nitrate ion, NO_3^-, is reduced to ammonia and water:

$$2NO_3^- + 9H_2 \rightarrow 2NH_3 + 6H_2O \qquad (2)$$

Because of loss by reduction, fresh additions of sodium nitrate must be made to the detinning solution from time to time in order to maintain a high detinning rate.

Some of the hydrogen is also removed by oxidation when the alkaline wetted metal is exposed to atmospheric oxygen. This occurs in the detinning operation when the scrap is tumbled in a partly submerged and slowly rotating drum.

In general, the rate at which tin is dissolved from the scrap depends on: (1) the concentration of the sodium hydroxide, (2) the concentration of the sodium nitrate, and (3) the temperature of the solution.

Separation of solid sodium stannate from the detinning solution — Once the alkaline solution has become saturated with sodium stannate, that which is subsequently

formed precipitates out of solution and collects as a heavy, crystalline solid in the bottom of the detinning tank. The solid stannate is periodically removed from the tank and separated as effectively as possible from associated detinning solution. This separation may readily be accomplished with a continuous centrifugal filter. Such a unit effects a good separation of solid from liquid, discharges the solid continuously at a high rate, requires neither filter cloths nor screens, and is ideally suited for the safe handling of hot, concentrated caustic soda solutions.

Conversion of sodium stannate to stannic hydroxide — After the solid sodium stannate has been separated from the detinning solution, it is dissolved in water in a suitable tank and allowed to stand until all of the foreign, insoluble matter picked up from the scrap during detinning has settled out. The clear stannate solution is then transferred to a second tank where it is converted to stannic hydroxide by controlled additions of sulfuric acid. The reaction for this change is shown by the following equation:

$$Na_2SnO_3 + H_2SO_4 + H_2O \rightarrow Sn(OH)_4 + Na_2SO_4 \quad (3)$$

The tin hydroxide thus formed appears as a white, insoluble compound and its precipitation is complete when the solution is at the neutral point. Sodium sulfate, the other product of the conversion reaction, remains dissolved in solution.

TABLE I
Theoretical Chemical Requirements for Tin Recovery
Basis: 100 lb metallic tin.

Chemical consumed	Amount required per 100 lb of tin	Approximate cost
Sodium hydroxide	67.4 lb	$2.53
Sodium nitrate	31.8 lb	0.82
Sulfuric acid (66 Be)	88.8 lb	0.90
Carbon	10.1 lb	0.10
Total approximate cost		$4.35

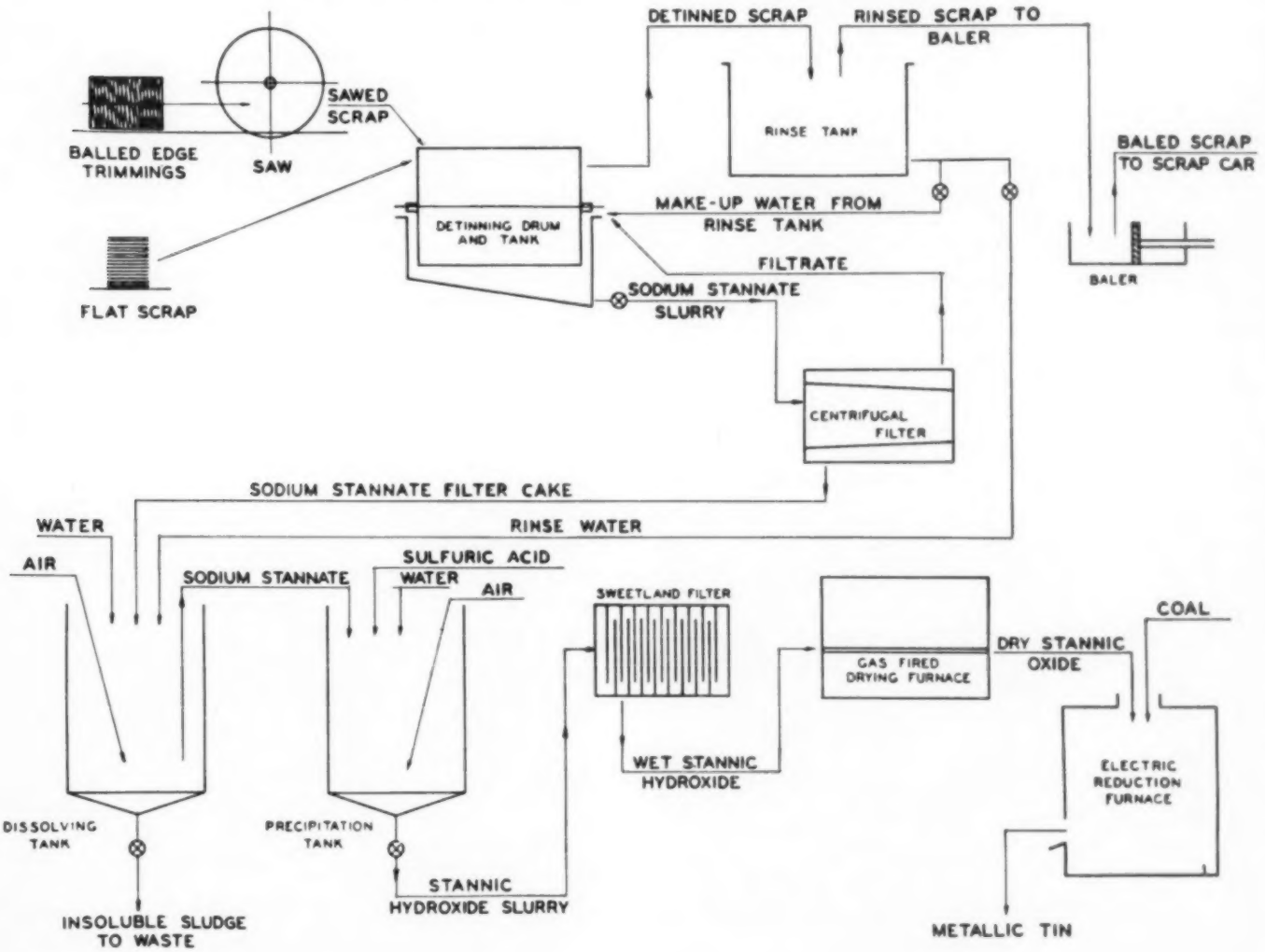
If an excess of acid is used, some of the tin hydroxide will react to form soluble stannic sulfate and thereby result in a loss of tin when the precipitated hydroxide is filtered. However, this loss can easily be avoided by the addition of a small amount of sodium carbonate to the solution after the addition of sulfuric acid has been completed in order to reprecipitate any dissolved tin.

The conversion from sodium stannate to stannic hydroxide can also be made with carbon dioxide gas. In this case the reaction is given by the equation:

$$Na_2SnO_3 + CO_2 + 2H_2O \rightarrow Sn(OH)_4 + Na_2CO_3 \quad (4)$$

The latter process is uneconomical as compared with the use of sulfuric acid unless a very cheap source of carbon dioxide is available.

Figure 1 — Flow chart of the detinning and tin recovery process.



Reduction to metallic tin — The precipitated stannic hydroxide is next filtered and washed free of most of the soluble sodium sulfate. The wet filter cake is then dried and mixed with crushed anthracite coal. When this mixture of hydrated tin oxide and carbon is heated to about 2200 F, the oxide is reduced to metallic tin as shown by the equation:

$$SnO_2 \cdot 2H_2O + C \rightarrow Sn + CO_2 + 2H_2O \qquad (5)$$

Table I summarizes the theoretical chemical requirements for removing 100 lb of tin from scrap and for converting the chemically combined tin back to the metallic state.

The approximate cost figures in Table I are to be considered as ideal and are included merely for the purpose of economic orientation. Obviously, the process cannot be carried out with a chemical consumption efficiency of 100 per cent and, depending on such factors as plant layout, equipment design, operating efficiency, etc., the actual chemical costs may be three or four times the ideal value.

PRACTICAL OPERATION OF THE DETINNING PROCESS

Figure 1 is a flow chart of the detinning process in operation at Weirton Steel Co. The scrap which is to be detinned enters the plant in two forms. These are:

1. Wound coils of edge trimmings from electrolytic tinplate.
2. Miscellaneous flat tinned scrap from both electrolytic and hot dipped sources.

The coils of edge trimmings, termed "balled scrap," are produced when coils of electrolytic tinplate are sheared to sheet size. In the shearing operation, the edge trimmings fall into a pit where they are gathered and tightly wound on a mandrel to form a coil which is 42 inches long and about 30 inches in diameter. These coils or "balls" weigh from 1500 to 1800 lb each. The free tin content of the ball may vary over a wide range since it depends on the coating weight of the strip from which it was sheared. Thus, a single ball may contain edge trimmings from electrolytic plate ranging in coating weight from 0.25 to 1.00 lb of tin per base box. In general, the tin coating weight of the narrow strip trimmed from the edges of the plated coils is considerably higher than the declared coating weight of the sheet from which the trim was cut. The reason for this is that the current density which determines the rate of deposition is always considerably higher along the edge of a sheet in the plating operation than on its flat surface.

Figure 2 — Charging hopper is loading a detinning drum.

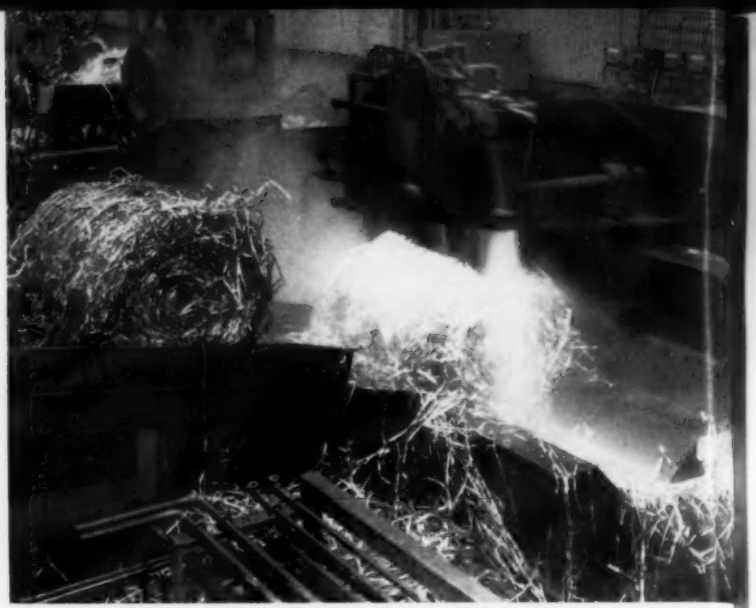


Figure 3 — A saw is used to cut a ball of edge trimmings.

Preparation of the scrap — As shown in the upper left of Figure 2, gondola cars bring the scrap directly into the plant for ease of unloading. All of the unloading is done with a magnet, and flat scrap is immediately placed in the charging hopper.

Before the edge trimmings can be detinned, the tin balls must be opened to form a loose, easily separable mass whose entire surface can be exposed to the action of the detinning solution. This is done by sawing the bundles lengthwise to a depth equal to its radius. When so cut, the coil falls open into a loosely tangled, flat mass which is easily detinned.

Figure 3 shows the cutting operation. The saw used for this purpose is ½ in. thick and 62 in. in diameter. It is driven by a 300-hp motor at 1800 rpm. During the cutting operation, water is applied to the periphery of the saw at a pressure of 400 psi in order to prevent the ends of the cut strands from fusing to a solid surface mass. Most of the cooling water drains to a sump from which it is recirculated after passing through screen strainers to remove small chips and strands of metal.

An average time of about two minutes is required to cut a ball of edge trimmings. This includes positioning the ball for cutting, the actual cutting time, and removing the cut ball from its bed. A trained saw operator can therefore prepare about 20 tons of balled scrap in one hour for the detinning operation.

The power input to the saw, its lateral movement along the saw bed, and the flow of cooling water is controlled from an elevated pulpit (not shown in Figure 3).

The cut balled scrap is further loosened when it is picked up by an electromagnet, and dropped into the charging hopper used for loading the detinning drums. Figure 2 shows the hopper with a charge of cut edge trimmings and a detinning drum in position to receive the scrap. The upper right of this photograph also shows a pile of balled scrap ready for cutting.

Detinning drums — Figures 4 and 5 show the scrap

holding drums employed in the detinning operation. These drums are approximately 8 feet in diameter and 11 feet in length. Their sides are covered with heavy mesh iron screen to permit free flow of the solution. They have solid end plates, one of which is removable for charging and discharging the scrap. Longitudinal steel baffles on the inner wall of the drums impart a tumbling action to the scrap when the drums are slowly rotated.

The drum is loaded in a vertical position as shown in Figure 2. It is then lowered to a horizontal position by means of a hydraulic lift. After the removable end cover has been replaced, the drum is picked up by a crane and moved into position in one of the detinning tanks.

Each drum has a charging capacity of from 5000 to about 6600 lb of scrap, the weight of the charge depending on the bulk of the material. Thus, a charge of edge trimmings, being more bulky, weighs less than a charge of flat scrap. Whenever possible, a mixture of both types of scrap is used in the charge because edge trimmings alone tend to form an undesirable packed mass during the slow rotation of the drum in the detinning operation. In general, the average weight of the charge is about 5400 lb.

Figure 4 shows a drum positioned in one of the detinning tanks. The drum rests on four flanged wheels mounted in the bottom of the tank and is engaged at one end by a coupling which is driven by a 3-hp motor through a reduction gear at 1 rpm.

Detinning tanks — The detinning tanks are constructed of ⅜-in. steel plate and are about 7 feet wide, 13 feet long, and 10 feet deep. They are provided with steam coils and they have a volume capacity of about 4600 gallons of solution when the charged drum is in position. At present, the plant contains five detinning tanks which are in continuous operation.

From 2 to 2½ hours are required to detin a charge of scrap, the time depending on the tin coating weight and on the composition and temperature of the solution.

The high operating temperature of the solutions (200 to 210 F) causes considerable steam formation which, if not attended to, would obscure the vision of the men working in the plant, particularly that of the overhead crane operators. This undesirable condition is eliminated by placing cover hoods over each of the tanks. These rest snugly on the rims of the tanks and completely enclose the drums during the detinning period. At the upper left of Figure 4 can be seen the end of one tank with its cover hood in position.

The composition of the detinning solution is maintained at 24 to 27 oz/gal of caustic soda and 3.5 to 3.7 oz/gal of sodium nitrate. Its tin content, when saturated with sodium stannate, depends on the caustic soda concentration and operating temperature. An average value for the concentration of dissolved tin under the operating conditions employed at Weirton is about 1.6 oz/gal (12 gm/liter) at room temperature.

Composition control of the solution is maintained by routine chemical analyses for free sodium hydroxide, sodium nitrate, and tin. Samples are taken once per 8 hour turn from each of the five tanks, and the required additions of nitrate and caustic soda are also made once per turn.

Handling the detinned scrap — After a charge of scrap has been detinned, the drum is lifted and held in suspension over the tank for about 30 seconds to drain off the solution. It is next successively immersed in two rinse tanks for the recovery of adhering sodium stannate. Its end cover plate is removed and it is then placed on a hydraulically operated lift which dumps the detinned steel into a scrap storage pit. Figure 5 shows this lift with one of the drums moving into a vertical discharge position.

The detinned scrap is lifted from the scrap pit into a baler charging box by means of a 55-in. electromagnet which is attached to a crane placed directly over the pit. The charging box dumps the scrap into a hydraulic press which forms it into tightly compressed bales weighing from 550 to 650 lb. These bales are ejected by the baler to a moving belt which carries them directly to a gondola car for delivery to the open hearth furnaces.

Recovery of sodium stannate — As stated previously, the sodium stannate formed when tin reacts with caustic soda will precipitate from solution once the solution has become saturated with respect to this compound. The solid sodium stannate which accumulates in the bottoms of the detinning tanks must therefore be removed for the recovery of its tin value. Filtration as-

Figure 4 — Detinning drum is placed in tank.

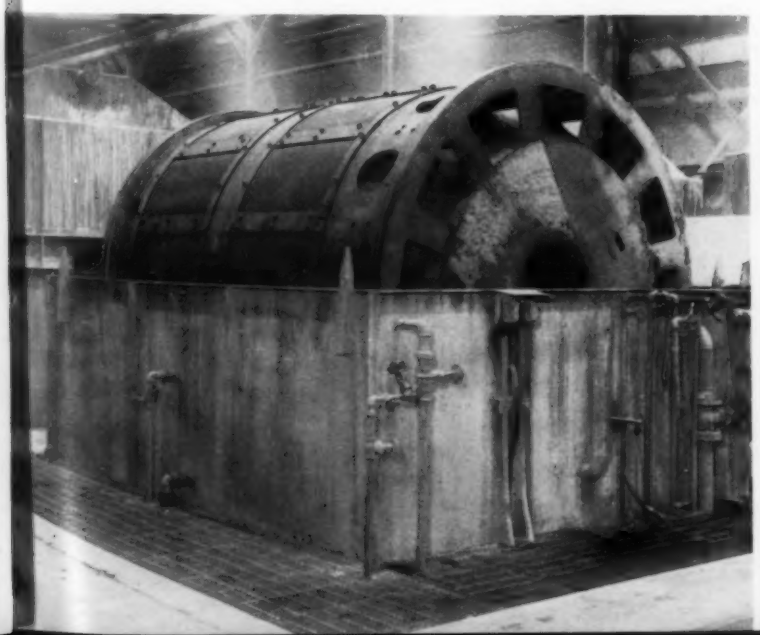


Figure 5 — One end of drum has a removable cover for discharging load of detinned scrap.

sures the most effective separation of solid from liquid, and a centrifugal filter is the preferred unit for this purpose.

A simple method for recovering the solid sodium stannate is to drain the tank of its solution through a line leading to the tank bottom by pumping the solution to a temporary storage tank. Fresh water is then pumped into the drained tank to dissolve most of the stannate. A compressed air lance serves as a convenient method for loosening the solid stannate and hastening the dissolving action. This solution and its thinned slurry is then pumped to a solution tank where the dissolving and clarification process is completed. Unless complete drainage is assured, a possible disadvantage of this method is poor separation of the detinning solution from the solid stannate. This would result in an appreciable loss of the caustic soda and sodium nitrate contained in the solution.

The practice at Weirton is to remove the accumulated sodium stannate from each tank after an average of 27 charges of scrap have been detinned. This represents about 54 hours of detinning time. With five tanks in operation, a batch of sodium stannate is therefore available for tin recovery every 11 hours.

The solid stannate removed from the detinning tanks always contains some insoluble foreign matter such as iron particles, rust, small bits of scrap, dirt, etc. This material is easily separated from the stannate solution by allowing it to settle for about 2½ hours after all of the stannate has been dissolved in hot water. The clear solution is then pumped to a precipitation tank for conversion to stannic hydroxide.

Conversion of sodium stannate to stannic hydroxide — Figure 6 shows the three rubber-lined tanks employed in this step of the process. The center tank is used to dissolve the solid stannate and to clarify the resulting solution. The two end tanks are used for precipitating tin hydroxide. The tanks are 9 feet high and 10 feet in diameter, and each has a volume capacity of 5300 gallons. All of the tanks are equipped with stainless steel steam heating coils.

Sulfuric acid (66 Be) is slowly added to the stannate solution until it is slightly acid to litmus paper. During the acid addition, the solution is vigorously air agitated and care is taken to keep its temperature below 160 F to avoid damaging the rubber lining.

Considerable heat is liberated in the conversion reaction. The sulfuric acid first neutralizes the excess sodium hydroxide which is introduced by entrained detinning solution and rinse water. It then converts sodium stannate to insoluble stannic hydroxide and soluble sodium sulfate as shown by the reaction in Equation 3. Soda ash is next added to the solution until its pH value is about 8.0 as determined by testing with phenolphthalein indicator.

Air agitation is continued for about half an hour after the precipitation reaction has been complete. This brings about a rapid coagulation of the precipitate. The precipitate is then allowed to settle. If the tin hydroxide has been properly precipitated, settling will take place quite rapidly.

The clear, supernatant solution, which consists mainly of dissolved sodium sulfate and some sodium nitrate, is next either siphoned or pumped off to waste. Water is then added to the tank. The slurry is air agitated and brought to a temperature of 140 to 150 F. This simple procedure quickly eliminates most of the sodium sulfate and effectively reduces the amount of washing required after the tin hydroxide has been filtered.

Filtering and drying the tin hydroxide — The hot slurry is next pumped to a filter under a maximum pressure of 50 psi. Stannic hydroxide is not a crystalline solid and is therefore not an easy material to filter. However, good filtration characteristics can be obtained if the temperature of the slurry is kept at about 140 F and if the water contains a small amount of sodium carbonate in solution. Under these conditions it is possible to obtain about one inch of filter cake on each side of the leaves of the filter in 2½ hours of filtration time. This amount of cake, when dried, produces about 400 lb of hydrated oxide.

The filter cake should be washed with hot water in order to remove most of the sodium sulfate which may be present. The reason for this is that the sodium sulfate carried over with the dried oxide is reduced to sodium sulfide in the reduction furnace. At the reduction temperature, sodium sulfide tends to combine with metallic tin to form volatile tin sulfide, some of which also appears in the slag and thus incurring an unnecessary loss of tin.

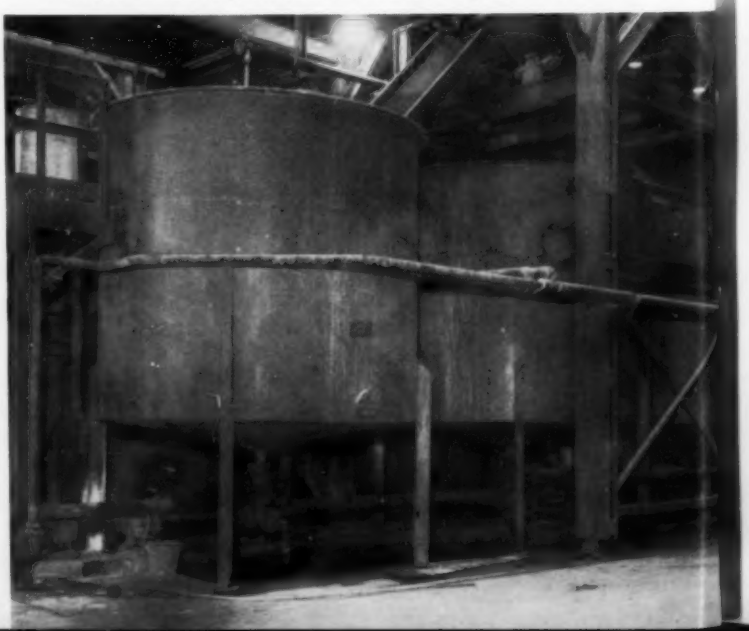
After washing the precipitate, hot compressed air is passed through the filter for about 15 minutes to remove part of the excess water and produce a dense and fairly dry filter cake.

The discharged filter cake is next transferred to a gas-fired drying furnace. This furnace, shown in Figure 7, is operated at 800 to 1000 F, and has a capacity for producing about 1200 lb of dry oxide in 8 hours. The drying operation not only removes the mechanically held water, but also a portion of the water of hydration so that the dried oxide is a mixture of $SnO_2 \cdot 2H_2O$ and $SnO_2 \cdot H_2O$.

Reduction of tin oxide to metallic tin — The dried oxide is mixed with crushed anthracite coal (buckwheat size) in the ratio of 15 lb of coal per 100 lb of oxide. This mixture is charged into a resistance type electric reduction furnace shown in Figure 8. A single charge for reduction generally consists of 600 lb of oxide and 90 lb of coal.

The reduction furnace is heated by means of two car-

Figure 6 — Solution and precipitation tanks are used to convert sodium stannate to stannic hydroxide.



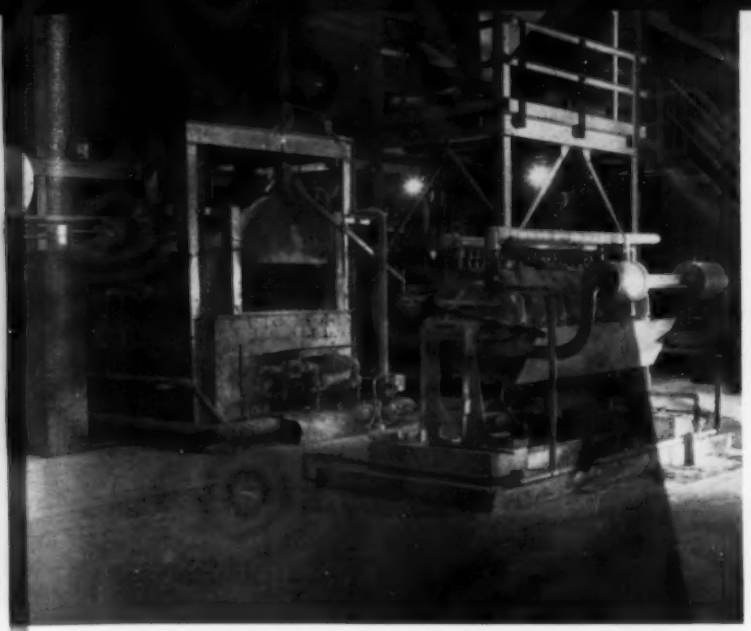


Figure 7 — Gas fired drying furnace and filter for stannic hydroxide.

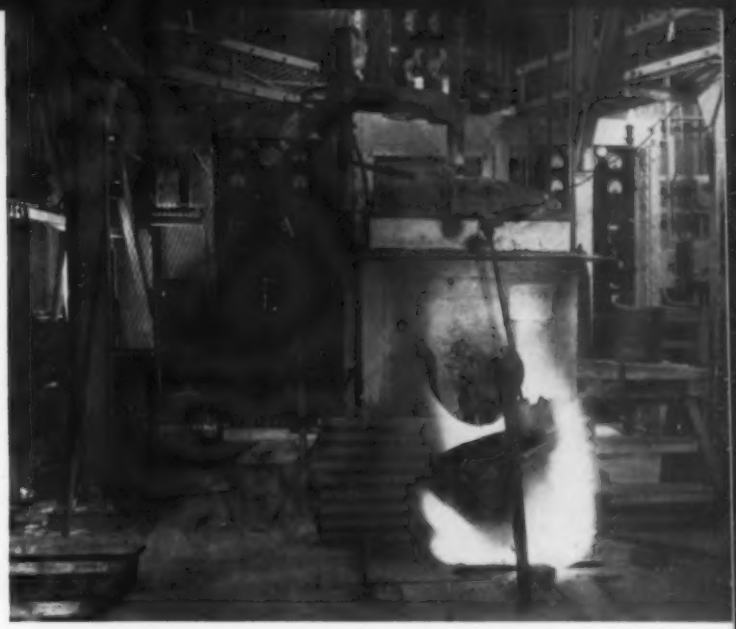


Figure 8 — Electric reduction furnace. Steel kettle in foreground is being heated to receive a tap.

bon electrodes which are fed by a 460-volt line reduced to 110 volts through a 50-kva transformer. Movement of the electrodes can be controlled either manually or mechanically.

The furnace is operated at 2200 to 2300 F at which temperature the oxide is in a molten state. A six hour reduction period is allotted for each 690-lb charge.

The plant is equipped with two reduction furnaces each of which has a capacity for reducing about 2400 lb of oxide per 24-hour day. Approximately 400 lb of tin are recovered from 600 lb of oxide, indicating an average recoverable tin content of 66.5 per cent.

The power consumption for the reduction of 600 lb of oxide over a six hour period runs quite consistently at 250 kwhr. A single furnace consumes about 30 carbon electrodes per month or approximately 1 electrode per turn. These electrodes are 2½ in. in diameter, 29 in. long, and weighing 9 lb each. The electrode consumption is estimated to be about 1 lb of carbon per 100 lb of tin recovered.

When a furnace is tapped for tin, the molten metal and slag is first run into a heated steel bucket as shown in Figure 8. The slag is removed by careful skimming and a jet of compressed air is then blown through the molten tin for about 5 minutes to remove oxidizable impurities. The metal is next poured through a stainless steel strainer into heated steel molds to form pigs of tin weighing about 100 lb each. Four such pigs of tin are shown in the lower left foreground of Figure 8.

PURITY OF RECOVERED TIN

Samples of the molten metal are taken at the beginning and end of every week's operation and these are spectographically analyzed for metallic impurities. A representative analysis from five different samples is given in Table II. The values show that the purity of the recovered tin is equal to that of good Straits tin.

TABLE II

Typical Analysis of Recovered Tin

Element	Per cent by weight
Lead	Less than 0.010
Antimony	Less than 0.018
Bismuth	Less than 0.001
Aluminum	Less than 0.003
Arsenic	Less than 0.01
Copper	0.015-0.027

ELECTRICAL SUBSTATION

The detinning plant at Weirton has its own substation to provide electrical power required for its operation. In this station, 6900 volts are reduced to 460 volts by means of an 1875-kva transformer. The reduced voltage is fed through a transformer breaker to a 460-volt bus having four 1600-ampere feeder lines. These lead respectively to the 300-hp saw motor, the general lighting system, and a line which provides power for a small repair shop. The fourth line passes through a 600-ampere breaker to a 365-kva transformer and then to a 300-kw sealed ignitron rectifier. The latter provides 250 volts, direct-current, which is used to power the traveling cranes and their 55-in. magnets.

CHEMICAL CONSUMPTION

The chemicals used in the detinning and tin recovery operation are 50 per cent caustic soda solution sodium nitrate, 66 degree Be sulfuric acid, and sodium carbonate.

A summary of the operating data for one month showed the average tin recovery to be 12.87 lb of tin per ton of scrap treated. This value is relatively low because the preponderance of the scrap consisted of edge trimmings from 0.25-lb electrolytic plate (that is, 0.25 lb of tin per base box). During this month, 109.5 lb of 50 per cent caustic soda solution were consumed per ton of scrap detinned. The consumption of chemicals per 1.0 lb of tin recovered was as follows:

Lb of 100 per cent caustic soda	4.26
Lb of 66 degree Be sulfuric acid	2.5
Lb of sodium nitrate	0.86
Lb of sodium carbonate	0.11
Lb of carbon electrode	0.01

Theoretically, 0.674 lb of caustic soda is required to react with 1.0 lb of tin. The difference between this value and the actual value of 4.26 represents caustic loss in drag-out on the detinned scrap and loss in separating the detinning solution from the solid sodium stannate. A certain amount of caustic soda is also lost by carbonate formation in the reaction between carbon dioxide in the atmosphere and sodium hydroxide in the detinning solution. However, out of these three items, the major caustic loss occurs in solution drag-out.

OPERATING PERSONNEL

The personnel employed to operate the day turn of the plant consists of 16 men whose jobs are classified as follows:

Clerk (day turn only)	1
Turn foreman	1
Solution operator and helper	2
Furnace operator and helper	2
Scrap baler and helper	2
Millwright and helper	2
Motor inspector (day turn only)	1
Crane operators	2
Laborers (day turn only)	2
Janitor (day turn only)	1
Total number of men	16

Out of this group, the solution operators and furnace operators are primarily responsible for the processing operations and the flow of material through the plant. Thus, the solution operator operates the saw which cuts the bundles of edge trimmings. He also, with the aid of a helper, directs the charging and discharging of the detinning drums, maintains the detinning solutions, separates the sodium stannate from solution, and converts the stannate to stannic hydroxide. The furnace operator and helper filter and dry the tin hydroxide, prepare the dried oxide for reduction, and reduce the oxide to metallic tin.

The baler helper operates the crane magnet which feeds the detinned scrap to the baling machine. Most of the mechanical adjustments, replacements, and repairs are made by the millwright and his helper.

PERCENTAGE DISTRIBUTION OF OPERATING COSTS

A breakdown of the major operating cost items shows the following approximate percentage distribution.

	Per cent
Producing labor	35
Chemicals consumed	28
Water, steam, electrical power, and gas	11
Reduction of oxide to metallic tin	3
All other operating expenses	23
Total	100

The first three items given above are those of major significance and show the relative cost distribution of labor and consumable materials. The relationship of operating costs to the value of the products recovered depends largely on the tin content of the scrap, since these costs are essentially the same for scrap of both low and high tin content. In general it can be said that the total operating costs for an efficiently operated plant should be about 30 per cent of the value of the tin recovered, plus the enhanced value of the detinned scrap.

BUILDINGS AND FACILITIES

The main building of the detinning plant is a steel structure 75 ft by 465 ft and 40 ft in height to the trusses. The floor area is approximately 35,000 sq ft. The walls and roof are constructed of corrugated steel sheets. A continuous flow ventilator, which can be adjusted to control the flow of air, runs along the entire length of the roof peak. To avoid interference with the roof ventilator, the building is windowless and illumination is entirely artificial.

Since practically all of the tinned and detinned scrap is transported by rail, a spur track for delivering scrap runs directly into the plant. Gondola cars enter and leave through a motor operated overhead steel door at one end. Detinned scrap is loaded into gondola cars on a second spur track directly adjacent to the building. The second track is also used for delivering sulfuric acid and 50 per cent caustic soda solution by tank car. At the other end of the building, a manually operated overhead door gives access to trucks.

Two 8-ton cranes, traveling on a runway 30 ft above the floor, handle all of the lifting operations other than those involved in feeding detinned scrap to the baling machine. A special crane placed directly over the scrap pit is used for the latter purpose.

A brick lean-to is attached to one wall of the main structure and houses the substation, chemical storage room, repair shop, and locker and washroom. Bags of sodium nitrate and soda ash are stored in the chemical storage room. Sulfuric acid and caustic soda solution, however, are stored in 10,000 and 15,000-gallon steel tanks, respectively, outside the building. Both tanks are supported on an elevated steel platform which permits gravity flow of the liquids through pipe lines leading into the building. Since 50 per cent caustic soda solution has a relatively high freezing point (about 52 F) its storage tank is insulated and equipped with steam coils for winter operation.

The locker and washroom provides steel lockers for the men, two open showers, and modern washing and toilet facilities.

A separate brick structure apart from the main building houses both the office and chemical control laboratory. The area between the office and the detinning plant, approximately 100 ft by 150 ft, is blacktopped and provides ample space for parking and for truck service.

SAFETY

Every foreseeable precaution has been taken to provide safe working conditions. Perhaps the most imminent hazard in the operation of this plant lies in the

danger of burns from the hot caustic detinning solution. Though complete mechanization of all of the material handling operations has eliminated direct contact with this solution, the danger of occasional splash burns still exists. On this account, all of the men are required to wear safety goggles. They are also provided with special rubberized gloves which are worn when any repair work on the detinning tanks must be made. An eye wash fountain and two quickly accessible emergency showers are available in the event of any caustic accident. Goggles, plastic face shields, and asbestos gloves are provided for the protection of the electric furnace operators. Goggles must also be worn by the saw operator.

Except for a few minor caustic burns, no serious accident has occurred during the first year of operation of the plant. Frequent inspections by Weirton's Safety Department have contributed in large measure to maintaining a high level of safety.

DISCUSSION

PRESENTED BY

C. J. DUBY, Chief Engineer, Republic Steel Corp., Cleveland, Ohio.

A. J. KROMBHOLZ, Assistant Head, Chemical Development and Research Div., Weirton Steel Co., Weirton, West Va.

EUGENE M. SMITH, Mill Research and Development Department, Youngstown Sheet & Tube Co., Youngstown, Ohio.

C. J. Duby: In talking about the precious metal tin that is coated on steel for containers and what not, it can readily be understood that a great many headaches have been caused in overcoming difficulties and problems encountered to produce this product from the ores in the land. Numerous operations and processes are required to obtain the finished product including all kinds of rigid inspections. In the end tin cans are made and packed with food products, etc. We now see the housewife take one of these cans from the cupboard shelf, cut one end open, empty the contents, put her foot on it and toss it into the refuse box. This is very discouraging to all those who helped make it, but however, it has served its purpose.

We are now trying to save this tin as a precious metal from the scrap. What happens to the tin on all of the cans thrown out on the refuse dumps? I have asked this question many times but got no satisfactory answer. An old law says "You cannot destroy matter, it returns back into nature." Well there are many tons of tin used in this country. Where does it finally go?

Now, assume 2500 tons of tin plate scrap a month. At $1.21 a pound and 12 pounds of tin per ton of scrap, the scrap tin would amount to a saving of about $400,000 a year. Then we would have the steel scrap to consider, and considering the steel scrap at $35.00, that would be $1,000,000. Adding the two, we get $1,400,000 of recovery.

We do know also that the tin scrap cannot be placed in the open hearth furnace. It will not do as open hearth melt scrap. The tin must be taken from it. Now we go to a lot of trouble taking the tin from the steel while nature does it quickly on the refuse dump. I do not know how soon, but it is done very quickly.

What would be the investment cost to install a plant as you have outlined? Also, instead of going through all the chemistry of this de-tinning, why not free the tin coating from the steel through a controlled atmosphere?

A. J. Krombholz: The cost of the detinning plant at Weirton Steel Co. was approximately $1,250,000.

It is difficult to see how tin could be effectively removed from scrap tinplate by a purely thermal process. If the scrap were heated to above the melting point of tin (450 F) in either an inert or a reducing atmosphere, an alloying action would immediately take place between the molten tin and the iron and thereby form the intermetallic compounds FeSn and $FeSn_2$. While a small portion of the tin on both electrolytic and hot dipped tinplate is already so combined in the alloy layer, remelting would cause further alloy formation and this action would continue as long as the tin was kept in the molten state. Furthermore, since the boiling point of tin is about 4100 F, recovery by evaporation would appear to be out of question even though no significant alloying action took place.

The object of detinning is to effect a complete separation of the tin coating from the steel and this can be efficiently and economically accomplished by a chemical process which removes the tin without attacking the steel.

Eugene M. Smith: Mr. Krombholz and the Weirton Steel Co. are to be commended for disclosing so completely the technical details of their de-tinning practice. The paper is unique in that the economics of the process is given the emphasis it deserves. In too many papers the cost of operation is left to the imagination of the reader.

After all, the return in dollars and cents still dictates the effort to be expended in overcoming operating obstacles. Unfortunately, it is the normal experience that data required to predict a suitable estimate for more exacting planning is never available until a process is in operation. For example, in the present paper consumption of chemical materials for de-tinning is easily determined by relatively simple arithmetic. To estimate that actual consumption of caustic when operating on a plant basis will be 6 to 7 times theoretical requirements is a much more hazardous task. To be able to make these necessary estimates we must rely on either our own knowledge or experience of others.

Thus, if members of our industry have the courage to encourage disclosure of the economics involved in new operating procedures, it will be a benefit to all. It will broaden the source from which we build our experience. Sometime it may conceivably convince those less familiar with our industry that returns on investments do not just happen but must be earned by employing ingenuity, careful planning and keen execution.

After reading this paper, it appears that Weirton has been able to adapt successfully the somewhat similar procedures reported to be used by the Goldschmidt De-

tinning Co. for recovering tin from tin plate. To the best of our knowledge, this is the first instance of an American tin plate producer recovering tin from scrap and, no doubt, it will encourage others to explore the possibilities of doing the same. Conservation of raw materials will be of benefit to the tin plate industry as well as be profitable to the industrial plants actually recovering the tin. With no intention to raise a discussion of the relative merits of the tin plating processes but merely as a contrast, experience with alkaline plating might be cited.

When making tin plate from an alkaline solution the throwing power is fortuitously superior to acid type plating baths. Heavy deposits of tin do not build up at the edge of the strip and hence no side trimming is necessary. On alkaline lines it is not common to side-trim after plating. Benefits arise in two ways. First, the power, plating capacity and tin consumption in plating heavy edges is not wasted. Second, the cost of reclaiming tin from the side trim is unexpended.

Scrap tin plate does still occur, however. The scrap consists primarily of welded coil ends, sheets from which tests have been cut and cobbles. If such scrap amounts to approximately 40 tons a month, the tin coating lost would be roughly $250 and the steel scrap value about $1750. Generally, tin plate scrap is sold to de-tinners for about 65 per cent of the above value.

As Mr. Krombholz states, the operating costs of a successful de-tinning plant must be about 30 per cent of the value of the tin recovered plus the enhanced value of the de-tinned scrap.

A review of the paper raises a number of technical questions:

1. In the Weirton process, the stripping solution contains 24 to 27 oz/gal caustic soda. What is the disadvantage in using a greater caustic concentration?

2. Liquid caustic of 50 per cent concentration (6.4 lb/gal) is stored in insulated steam heated tanks because of a freezing point of 52 F. Would there be any advantage in diluting the caustic to 20 per cent concentration (2 lb/gal) upon receiving it in the winter months to benefit by depressing the freezing point to —14 F?

3. To separate sodium stannate from foreign matter such as scrap, iron particles and rust, the stannate is dissolved in hot water. To what temperature is the water heated? Since the solubility of sodium stannate decreases as the temperature increases, would cold water not be advantageous? What is the concentration of sodium stannate and caustic of the solution to which the sulfuric acid is added?

4. In the reduction furnace, is there a brick or monolithic hearth? Does leakage from the furnace present a problem because of the fluidity and low freezing point of tin? How much would recovery suffer if the tin oxide were not heated to the liquid state? How much slag is tapped from the furnace and what is the tin concentration in the slag?

5. The capital cost of the plant and equipment has not been mentioned. From the illustrations presented and the verbal description of the plant, one might guess the cost to be about $1,200,000. If this suggested figure were the capital cost, it would be equivalent to about $1.00 per lb of tin recovered annually.

A. J. Krombholz: The major disadvantage of using caustic concentrations greater than 24 to 27 oz/gal is an increase in caustic loss by drag-out when the detinned scrap is removed from the detinning tanks. There is a considerable loss in free caustic soda even after two rinsings of the scrap, and it is doubtful whether the relatively small increase in detinning rate offered by a more concentrated solution justifies a greater caustic drag-out loss.

If the 50 per cent caustic soda solution were diluted to a 20 per cent solution for purpose of lowering the freezing point to about —14 F, one would have to meet two new consequences: (1) the solution storage capacity would have to be increased two and a half fold, and (2) the volume of caustic solution required to maintain the caustic concentration in the detinning solution would be two and a half times greater than that required with a 50 per cent solution. This extra volume space is not always available in the detinning tanks, especially when these are in continuous operation and when caustic additions are made only once in each 8-hour turn.

Weirton's storage tank for caustic solution has a capacity of 15,000 gallons. It was considered more economical to provide this tank with insulation and steam coils, and thereby maintain the advantage of using the solution as received, than to construct storage capacity for about 40,000 gallons of 20 per cent solution.

Originally, the solution was heated to hasten the dissolving action. Our present practice is to use cold water for dissolving the sodium stannate. The concentration of sodium stannate and free sodium hydroxide prior to the addition of sulfuric acid varies somewhat from charge to charge. In general, however, about 1260 lb of tin are recovered from 3500 gallons of stannate solution. This is equivalent to 10.3 oz of sodium stannate per gallon. An average value for the free caustic concentration in the stannate solution is approximately 4 oz/gal.

At present, the hearth in the reduction furnace is made with a rammed mix. When the original hearth of refractory brick was replaced by this, very little tin was found below the hearth brick. Hence, leakage of tin has not been a problem.

Reduction of the oxide in the solid state has not been tried because reduction in the liquid state has proven to be both rapid and complete. The liquid state also gives a clean separation of tin and slag when the furnace is tapped; that is, very little free tin is dispersed throughout the molten slag.

The average weight of slag tapped from the furnace per 690-lb charge (600 lb of oxide and 90 lb of coal) is approximately 50 to 60 lb. Its tin content is about 1.0 to 1.5 per cent. Much of this tin is in the form of small metallic globules, most of which are recovered when the slag is reworked and screened.

Mr. Smith's estimate of the capital cost of the plant and equipment is very close indeed. As stated before, the cost was approximately $1,250,000.

Mechanization of 12-in. Bar Mill

By G. A. HENDERSON
Superintendent of Mills
Bethlehem Steel Co.
Lackawanna, N. Y.

. . . . rebuilding of mill has increased efficiency and production . . . .

▲ THE first bar mill put into operation at the Lackawanna plant of the Bethlehem Steel Co. on January 1, 1905, was a 16 - 12 - 8-in. merchant bar mill shown in Figure 1. The two 10 x 34 ft producer gas fired continuous furnaces were designed to heat 400 tons of billets up to 6 in. x 6 in. x 9 ft long in 24 hours. The 16-in. mill consisted of three stands: two 3-high and one 2-high in a single train; the 12-in. mill of 4 stands, three 3-high and one 2-high, another single train and two 8-in. two high stands. All were driven by one 1500-hp horizontal vertical compound steam engine, 28 x 50 x 48 in. of 110 rpm. The 16-in. mill was direct connected to the engine through 16-in. pinions, the 12-in. mill was belt driven from the engine fly wheel pulley through 12-in. pinions, and the 8-in. mill by pulley, belt and jack shaft through 8-in. pinions. A 140-ft roller table conveyed the billets from the furnaces to the first stand in the 16-in. mill. Overhead hooks were provided for assisting in handling bars at the 16-in. mill. Idle table rolls were placed at floor level on each side of the 12-in. mill. The remainder of the mill floor between stands and extending 100 ft on either side of the mill, was covered with 1-¼-in. cast-iron plates. Catchers and pull over men handled and manipulated the bars across the mill and in the passes.

The layout permitted finishing bars off the last stand in each train. The 16-in. mill delivered to a flat sawtooth rack cooling bed 25 ft x 100 ft. The 12-in. and 8-in. mills delivered to an automatic sloping cooling bed 250 ft long, or to coilers in case of the smaller size bars.

The 16-in. mill dimensions:

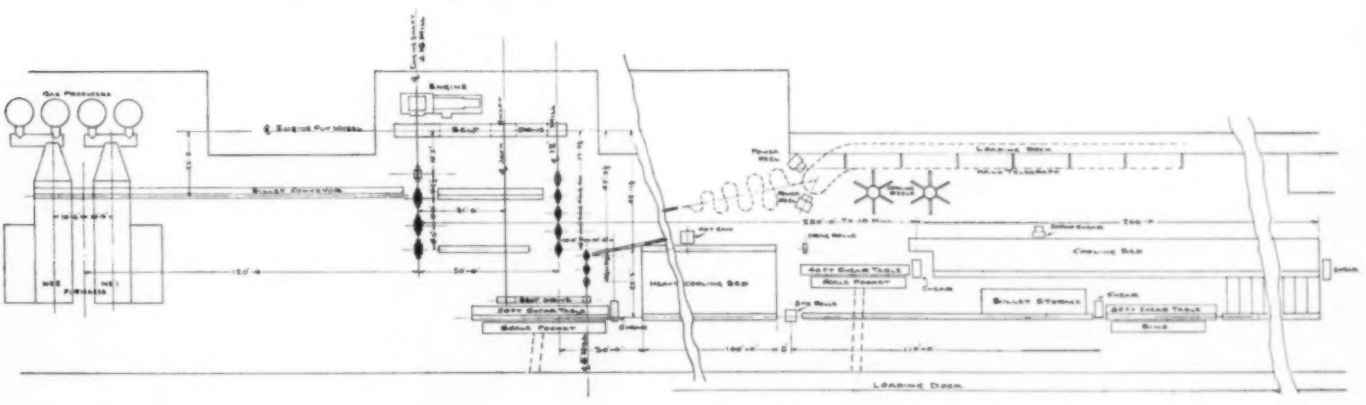
Rougher	16 x 54 in.
Intermediate	16 x 42 in.
Finisher	16 x 18 in.

Roll and pass arrangement as shown in Figure 2 is for 3-in. rounds out of 5 x 5-in. billets in 7 passes.

Products finished on the 16-in. mill:

Tie plates up to 8-¾ in.
Splice bars—100 to 55 lb
Beams—4 and 3 in.
Channels—4-⅛ and 3 in.
Angles—3-½ x 3-½ in. to 2-½ x 2½ in.

Figure 1 — Original 16-12-8-in. merchant bar mill at Lackawanna plant.



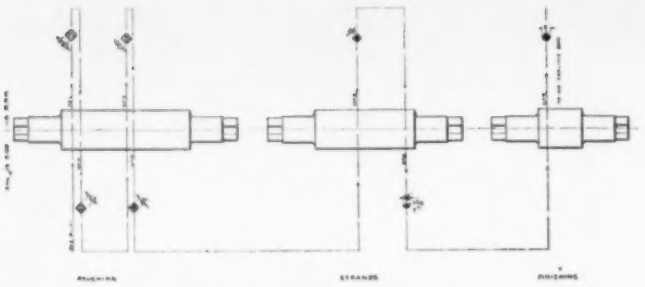


Figure 2 — Roll and pass arrangement for making 3-in. rounds in seven passes.

Rounds—3 to 2 in.
Squares—3 to 2-⅛ in.
Flats—6 in. to 4 x 2 in. to ¼ in.
Special shapes.

12-in. mill roll dimensions:

Rougher ..... 12 x 20 in.
Strand ..... 12 x 20 in.
Leader ..... 12 x 20 in.
Finisher ..... 12 x 20 in.

Figure 3 shows roll and pass arrangement for 2-in. rounds from 4 x 4-in. billets in 8 passes.

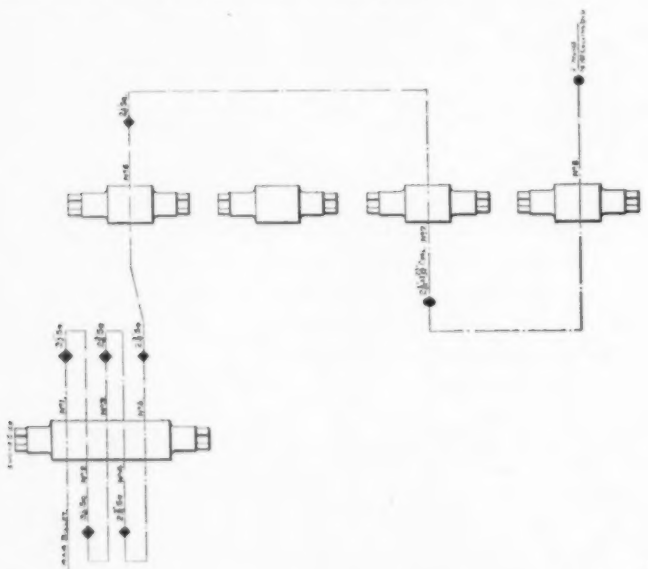


Figure 3 — This roll and pass arrangement is used for making 2-in. rounds from 4 x 4 in. billets in 8 passes.

Figure 4 shows roll and pass arrangement for 9/16-in. rounds from 4 x 4-in. billets in 10 passes.

Products finished on the 12-in. mill:

Splice bars—50 to 12 lb
Rails—25 to 12 lb
Rounds—2 to 9/16 in.
Squares—2 to 9/16 in.
Flats—4 in. to 1-½ x 1 in. to 3/16 in.
Concrete bars—1-½ to ½ in.
Angles—2-½ x 2-½ in. to 1 x 1 in.
Special shapes.

8-in. Roll dimensions:

Two stands—8-½ x 12 in.

Figure 5 shows roll and pass arrangement for ⅜-in. rounds from 1-¾ x 1¾-in. billets in 8 passes.

Figure 6 shows roll and pass arrangement for ½-in. rounds from 4 x 4-in. billets in 12 passes.

Products finished on the 8-in. mill:

Rounds—½ to ¼ in.
Squares—½ to ¼ in.

No tonnage records are available for this mill. However, some of our old timers state that the best the mill ever did was about 250 tons on a 12-hour shift, rolling "Big" rounds off the 12-in. mill.

When this mill could no longer supply the demand for the variety of bar sections it rolled, the need for another bar mill in the plant was realized, and in September, 1911, a 10-in. bar mill was added to the plant facilities. Alterations followed on the 16 - 12 - 8-in. mer-

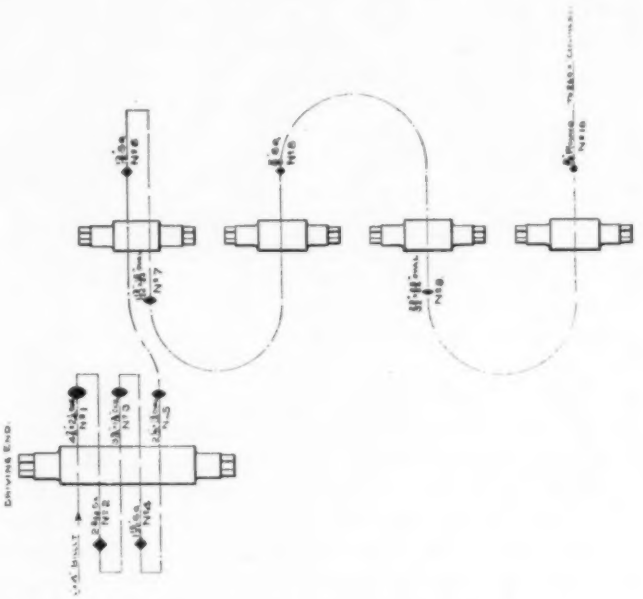
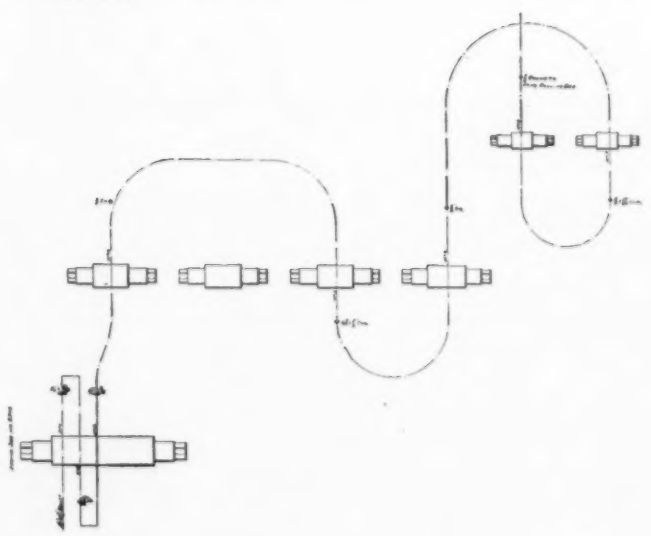


Figure 4 — Roll and pass arrangement is used to reduce 4 x 4-in. billets to 9/16-in. rounds in 10 passes.

chant bar mill. The 16-in. intermediate stand was removed. This stand was later used in the train of a 24-in. rail, splice bar and tie plate mill. The 16-in. finisher was scrapped. The two 8-in. stands were also removed.

What remained was a conventional Belgium-type hand mill consisting of the 3-high 16-in. rougher fol-

Figure 5 — This roll and pass arrangement was used to produce ⅜-in. rounds from 1¾-in. square billets in 8 passes.



lowed by four 12-in. stands in the single train all driven by the original 1500-hp steam engine. Figure 7 shows this mill.

Sections rolled on this mill were rounds, squares and flats, also small angles and limited shapes.

In 1929, the 1500-hp steam engine was replaced by an 1850/1450/925-hp, 6600-volt, 25-cycle, a-c Scherbius adjustable-speed 120/94/60-rpm motor.

The monthly production record of this mill was made in May, 1929 when 10,890 net tons were produced. This record remained until the mill was dismantled in 1940.

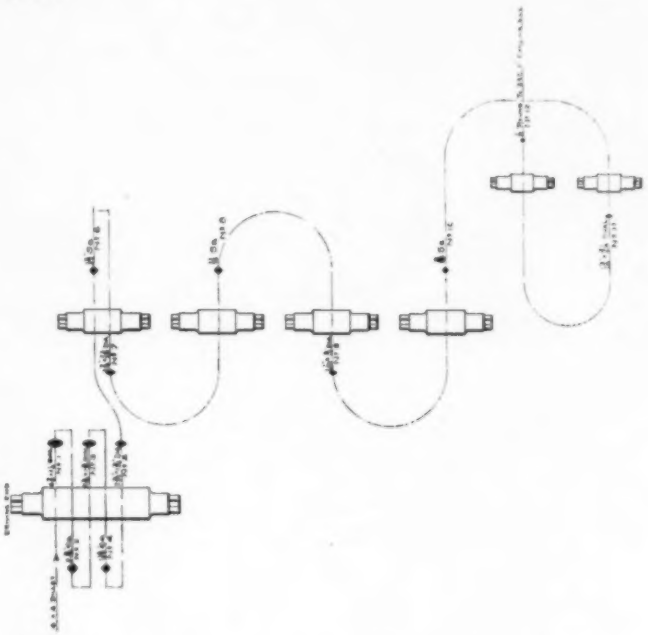


Figure 6 — Pass arrangement used to develop ½-in. rounds from 4 x 4-in. billets in 12 passes.

No other major changes were made until the year 1940 when the mill was moved to its present location. At this time spacious buildings were provided for billet preparation and storage and finishing and shipping. Two modern gas and oil fired furnaces for handling 15-ft 6-in. long billets and a modern hot bed were installed. The plan of the mill is shown in the top drawing of Figure 1 in the following article by Mr. Dague. Roll dimensions and speeds are shown in Table I.

Figure 7 — A 1500-hp steam engine drove the 16-in. rougher and four 12-in. stands in a single train.

At that time, due to the demand for a wide range of sizes and qualities, including alloys, rather than for quantity production of a limited number of standard sections, a jobbing mill was considered more suitable than a continuous mill or a cross-country mill. The general arrangement of the mill stands, therefore, remained the same. There were, however, mechanical and electrical improvements added which made the mill a really up-to-date jobbing mill for that particular time.

A scale breaker with horizontal and vertical rolls was placed ahead of the 16-in. rougher and a 1000-lb per sq in. hydraulic water spray system was put into service for descaling and scale removal. The 16-in. rougher was driven by the same 1850/1450/925-hp, 6600-volt, 25-cycle a-c Scherbius drive motor. Two 800-hp, 600-volt, d-c motors operating in parallel, with gear reduction, were provided to drive three of the 12-in. stands, the rougher, the strand and the leader, while an 800-hp, 600-volt, d-c motor, with gear reduction, provided an independent drive for the finisher. To improve handling bars through the mill, a tilting table with automatic pass-positioning sideguards was installed on the delivery side of the 16-in. rougher; driven table rollers were placed on the entry side and idle table rollers on the delivery side of the 12-in. stands. Bars were positioned for succeeding passes in the 12-in. stands by chain transfers, but the bars were manipulated into the guide boxes by hand. On light flat sections hand-looping was practiced.

TABLE I

Sizes and Speed of Rolls — 1940 Mill

Stand		Diameter and length, in.	Speed, rpm
(3 High)	16-in. Roughing	16 x 54	120-60
(2 or 3 High)	12-in. Roughing	12 x 20	216.8-144.5
(2 High)	12 in. Strand	12 x 20	216.8-144.5
(2 High)	12-in. Leader	12 x 20	216.8-144.5
(2 High)	12-in. Finishing	12 x 20	216.8-144.5
(2 High)	12-in. Finishing	20 x 20	216.8-144.5

The mill processed 5 x 5 and 4 x 4-in. billets up to 15-ft 6-in. long into normal 12-in. mill dimensioned bars, in 6 to 12 passes as follows: three, five or seven passes in the 16-in. rougher; one or two passes in the 12-in. rougher; one or no pass in the strand, and one pass each in the leader and finisher. It was still a hand mill, using approximately 75 per cent 4 x 4-in. billets and the balance 25 per cent 5 x 5-in. billets. With this arrangement, the mill's average monthly production was 13,500 tons at an average of 25 tons per hour.

THE PRESENT MILL

With the new 10-in. continuous bar mill in operation after April, 1947, and the trade constantly increasing the demand for bars, the size range for the 12-in. jobbing mill became limited to its larger sizes which were being required in larger quantities. The need for a more economical mechanized mill, to produce larger quantities in the size range possible from a 12-in. mill was needed.

During a 16-day shutdown period, the mill was re-

Figure 8 — Illustration shows mill as it was in May, 1949 prior to its last rebuilding in 1950.

vamped and converted from a Belgium-type into a cross-country type mill. The mill was down from 7 a.m., March 16, 1950 to 7 a.m., April 1, 1950 when it started single turn operation. On April 10, 1950, (9 days later) it resumed triple turn operation.

The mill is now an 8-stand cross-country mill shown in plan in the bottom drawing of Figure 1 in the following article by Mr. Dague.

The first two stands are 18-in. mills spaced on 30-ft centers. The drive for these mills consists of two sets of 18-in. pinions driven by one 600-hp motor through bevel gears and a common gear drive. The third stand, located 38-ft 6-in. from No. 2, is the original 16-in. rougher, where one or three passes are made. No change was made in the drive for this stand. Stand No. 4, a 14-in. mill, is located 80 ft from No. 3 stand and is in the same location as the old 12-in., 3-high rougher.

TABLE II

Sizes and Speed of Rolls for Present Mill

Stand	Diameter and length, in.	Speed, rpm
18-in. Mill — No. 1 Stand	18 x 30	29.2-14.6
18-in. Mill — No. 2 Stand	18 x 30	48.8-24.4
16-in. Mill — No. 3, 4, 5 Stand	16 x 54	120-60
14-in. Mill — No. 6 Stand	14 x 31	216.8-144.5
12-in. Mill — No. 7 Stand	12 x 20	240-120
12-in. Mill — No. 8 Stand	12 x 20	240-120
12-in. Mill — No. 9 Stand	12 x 20	216.8-144.5
12-in. Mill — No. 10 Stand	12 x 20	297-148

Stands No. 5 and 6 are 12-in. mill and are located 145-ft 6-in. beyond No. 4. The drive for stands No. 5 and 6 consists of two sets of pinions driven by one 1700-hp, 600-volt, d-c motor through a common gear drive. The 12-in. leader remained in its original location and is driven from No. 4 stand through a set of 12-in. pinions located in the position of the original 12-in. strand. The drive for the 14-in. stand and the leader are the two 800-hp, 600-volt, d-c motors operating in parallel that formerly drove the 12-in. rougher, strand and leader and remained on their original foundations. The finisher and its 800-hp, 600-volt, d-c motor drive with gear reduction also remained in its original location. (*Note*: In February, 1951 the finisher motor and gear reduction were changed. To insure finishing capacity, a high speed 1250-hp, 600-volt, d-c motor replaced the 800-hp motor).

Complete new roller tables were installed to convey the bars between the 14-in. (No. 4) rougher and the finisher. Skew "Y" tables transfer the bars between the fifth and sixth stands; and between the leader and the finishing stands.

Roll dimensions and speeds are shown in Table II. Delivery speed of the finisher is from 510 to 1118 fpm.

To reduce manpower, eliminate hand manipulation and increase production, retractable, mechanical bar turners are positioned at the entry of all passes except No. 1 and No. 4. No. 4 pass is used when three passes are required in the 16-in. rougher. The tilting table positions the bar for entry, a twist box mounted on the rest bar turns the bar before entry in the No. 4 roll pass. The mechanical bar turners are operated by air cylinders controlled by solenoid-operated air valves which work automatically through electric eye control. Provision is also made for the pulpit man to control their operation. Figure 9 shows the finishing stand before the change.

Figure 9 — Originally bars were turned manually.

Figure 10 shows the bar turners at finishing stand. Figure 11 is a general view of mill. Figure 12 is a general view of 225-ft hot bed.

Figure 10 — Illustration shows bar turners at finishing stand.

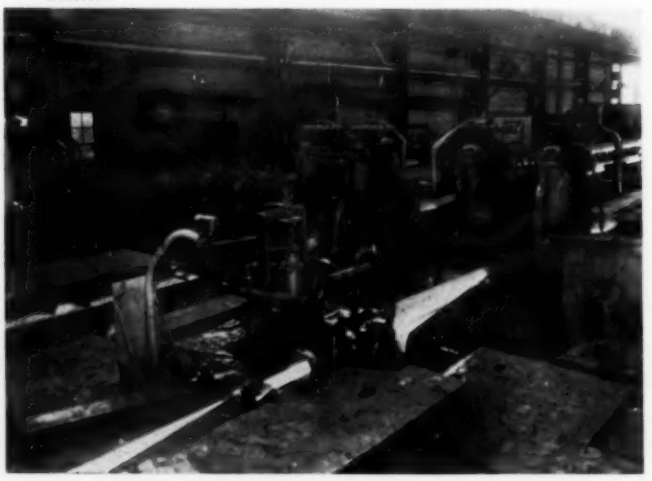


Figure 11 — General view of 12-in. bar mill.

The efficiency, economy and capacity of the mill have been improved by the change in billet size, the labor saving devices, the standardization of the mill furniture, and the use of improved roll-pass design.

The mill now uses 80 per cent 5 x 5-in. billets up to 15-ft 6-in. long and only 20 per cent 4 x 4-in. billets up to 15-ft 6-in. long. The latter are used only on some flats, preformed sections and small squares.

Mechanization for handling bars between passes reduced the manpower required on the mill by 18 men per turn. The mill formerly required 33 men per turn and now takes 15 men per turn; that is, on the mill proper from roughers to hot bed.

Roller guides are used in all passes from No. 6 to No. 10 except on a few sections of squares; on these we have special solid guides that fit the roller guide box. All rest bars for all stands were designed to accommodate roller guide boxes; entry and delivery rest bars are identical, thus eliminating the number of spare rest bars and making it possible to have one design and size of side-guard for holding delivery guides.

Having provided considerable inventory of 4 x 4-in. billets ahead of the mill when this change was made, the mill was started on old pass lines; however, by using diamond and square design in passes No. 3 and No. 6, it is possible to roll a greater range from 5 x 5-in. billets than on the old mill. This has reduced the number of rolls and roll changes necessary for the mill cycle. For example, on rounds, squares and concrete bars, we formerly used 6 sets of 16-in. roughing rolls. We now have two sets, one for 5 x 5-in. billets, and one for 4 x 4-in. billets. For flats we had 8 sets of 16-in. roughers.

Figure 12 — Hot bed is 225 ft long.

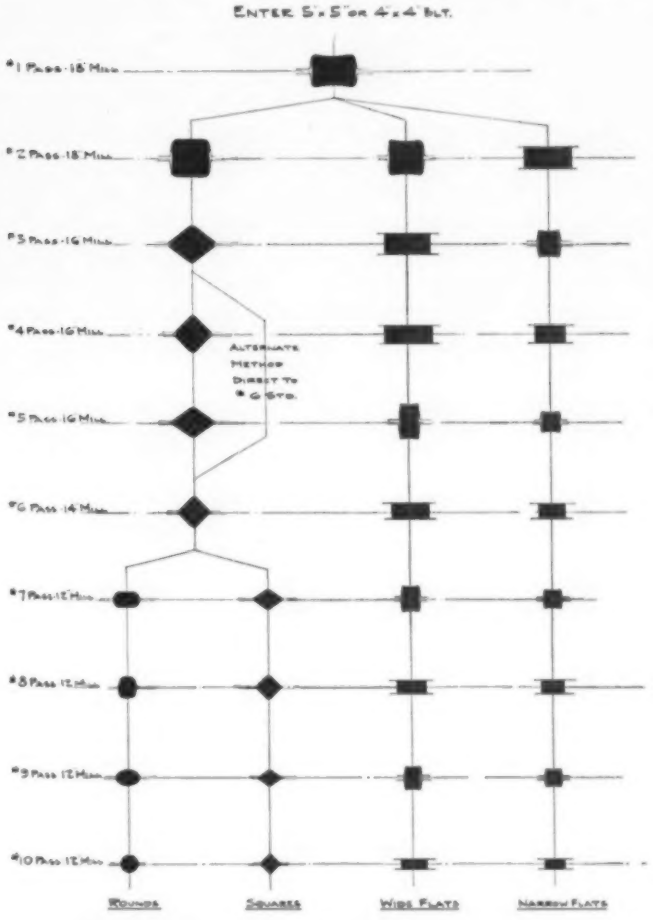

ENTER 5"x5" OR 4"x4" BLT.
#1 PASS - 18" MILL
#2 PASS - 18" MILL
#3 PASS - 16" MILL
#4 PASS - 16" MILL
ALTERNATE METHOD DIRECT TO #6 STD.
#5 PASS - 16" MILL
#6 PASS - 14" MILL
#7 PASS - 12" MILL
#8 PASS - 12" MILL
#9 PASS - 12" MILL
#10 PASS - 12" MILL
ROUNDS
SQUARES
WIDE FLATS
NARROW FLATS

Figure 13 — Typical layout of sections rolled on 12-in. bar mill.

Now we have one set for each size billet, 5 x 5-in. billets for flats—4-in. to 2-½ x 2-in. to 9/16-in., and 4 x 4-in. billets for range 2-3/8-in. to 1-½-in. x 2-in. to 9/16-in.

The complete cycle on the mill can be produced on one set of rolls for first pass; two sets for No. 2, four sets for the 16-in. rougher and three sets for the 14-in. stand.

Figure 13 shows a typical layout of sections rolled on the mill. Table III shows the progress being made.

The average quarterly figures prior to the change-over are for the period 1947 to the first quarter before the change-over was made in March, 1950. The mill, in that period, averaged approximately 13,500 tons per

TABLE III

Progress Chart — 12-In. Mill

Period	Time operated, hours	Down time, hours	No delay time, hours	Down time, per cent	Total production, tons	Hourly production, tons
Before change						
Average 3 months	1711	487	1224	29	42,284	24.7
After change						
First 3 months	1687	827	860	49	24,699	14.6
Second 3 months	1889	795.5	1093.5	42	35,430	18.8
Third 3 months	1614	565.5	1048.5	35	42,224	26.2
Fourth 3 months	1392	433	959	31	45,522	32.7
Fifth 3 months	1584	496	1088	31	57,064	36.0

month, at 24.7 tons per hour. Average down time was 29 per cent.

The first three-month period of operation immediately after the change shows 49 per cent down time and an average production of only 14.6 tons per hour. This relatively poor performance is due primarily to two reasons. First, the crews had to acquaint themselves with new equipment, and second, the use of old pass lines to use up rolls on hand and the stock of 4 x 4-in. billets was a decided handicap. As time went on, the crews became more proficient and the new pass lines were employed which permitted the use of more 5 x 5-in. billets. Within a year these factors had reduced the actual down-time to about 31 per cent and the tons per hour increased about 2-½ times. The down time has now returned to normal and the tons per hour has increased from an average of 24.7 with the old Belgium-type, to 36 net tons per hour with the new cross-country layout, an increase of 46 per cent.

Sections now rolled on the mill are as follows:

Rounds—2-$^{9}/_{16}$ to 1-$^{19}/_{32}$-in.
Squares—2-¾ to 1-in.
Flats—4-in. to 1-½-in. x 2-in. to $^{9}/_{16}$-in.
Preformed sections.

The cycle of sections is repeated monthly.

In conclusion, the following statistics show that while the mill is still as flexible as the old hand mill, the higher production rate and the additional savings attained as pointed out before, make it more economical and capable of supplying greater tonnages of carbon and alloy bar sections within its range.

Table IV shows comparative mill records before and after the changes. Before the mill changes in March, 1951, the monthly tonnage record for the mill, made in March, 1945, was 17,527 net tons, produced in 648 hours, or 27 tons per hour; this was with the mill operating 18 turns per week. The best average tons per hour for any one month was 30, for 557 hours in May, 1945.

After the mill changes, the present monthly record, made in July, 1951, is 22,080 net tons, produced in 600 hours or 37 tons per hour; the mill operated 15 turns each week with one exception when it operated 18 turns. In June, 1951, the mill operated 527 hours at a 40-ton per hour rate.

The present 8-hour record is 591 tons or 73.88 tons per hour, made on June 30, 1951 while rolling 2-½-in. rounds from 5 x 5-in. billets. A 24-hour record was established the same day, 1456 tons, an average of 60.7 tons per hour.

Present operations indicate that the mill can and will improve with increased demand for bars in its present range.

TABLE IV

Comparison of Production Records — 12-In. Mill

	Monthly record, tons	Hours operated	Average tons per hr	8-Hour turn record		24-Hour record	
				Tons	Tons/hr	Tons	Tons/hr
Old mill	17,527	648	27	544	68	1400	58.4
New mill	22,080	600	37	591	73.88	1456	60.7
Increase tons	4,453	...	10	47	5.88	56	2.3
Per cent improvement	25.2	...	37.0	8.65	8.65	4.0	4.0

DISCUSSION

PRESENTED BY

CLAYTON SQUIER, Assistant to Electrical Superintendent, Electrical Department, Bethlehem Steel Co., Lackawanna, N. Y.

G. H. McCALLY, Plant Superintendent, Burlington Steel Co., Hamilton, Ontario, Canada.

G. A. HENDERSON, Superintendent of Mills, Bethlehem Steel Co., Lackawanna, N. Y.

WARREN C. THIRY, Application Engineer, General Electric Co., Schenectady, N. Y.

JAMES O. DAGUE, Assistant Superintendent, Mechanical Department, Bethlehem Steel Co., Lackawanna, N. Y.

Member: In your operations your bar turner units operate through the electric eye. These units operate a little differently, and I wonder if there is anyone here who wants to talk about that. I believe the heat of the bar is the determining factor that controls these units.

Clayton Squier: These are special photo-electric re-

lays that are sensitive to infra-red and they pick up as the bar passes just ahead of the bar turner. The infra-red sensitive photo-electric relay picks up another relay, which in turn actuates the solenoid, which operates the pilot valve for the air cylinder, which actually turns the bar. In most installations, there is usually a light source on one side and a photo-electric relay on the other side, the bar going through interrupts the light beam and the photo-electric relay then initiates the relay to operate the bar turner. In this case, we use the infra-red from the bar to set off the operation.

G. H. McCally: I would like to know, if, before the modernization of this mill, you had two furnaces?

G. A. Henderson: The two furnaces were put in the mill in 1940, when it was transferred from the old location where it was originally planted in 1905. The mill was remodeled and transferred to its present location and the two furnaces installed. They are fired with straight coke oven gas or Bunker-C oil.

G. H. McCally: You mentioned a descaler in your 16-in. breakdown. Do you still have the descaler?

G. A. Henderson: No. The scale breaker was removed when we made the alterations.

G. H. McCally: Was that due to the two furnaces?

G. A. Henderson: No. We originally felt that we needed the descaler to take care of the bars on the original mill, that is, the mill that was put in there in 1940. When we made these alterations, we felt that the two 18-in. roughers would break the scale, and it has functioned the way we had expected. We have hydraulic descalers there now, and no mechanical scale-breaker.

Warren C. Thiry: You emphasized the fact that excavation was kept to a minimum since there was no need to provide room around the form for men to do additional work once it was lowered into position. Since you must have had to plumb these large heavy forms and bring them to a definite elevation, was it necessary to make special provision for jacking from inside to bring them to their final position before pouring?

James O. Dague: From the inside. Any mill of that form and magnitude is pretty much one large glob of concrete and anywhere there is concrete you do not have a form. The conventional mill form starts off, you might say, by a hollow box. It has no bottom. They level off roughly, as you set on the original concrete, or in this case, on the mat. When you put this form in, you can allow less clearance on the outside than normally, because you actually do not have to work on the outside. You go in the inside and are working on a walled section, so that actually whether you are working on the inside or outside makes no difference. That is how we worked, from the inside.

PITTSBURGH DISTRICT SECTION

of

ASSOCIATION OF IRON AND STEEL ENGINEERS

Announces an

INSPECTION TRIP TO BETHLEHEM STEEL COMPANY

JOHNSTOWN PLANT

MONDAY, MAY 4, 1953, 1:00 P. M.

A dinner and talk will be held in the evening

FURTHER DETAILS WILL BE ANNOUNCED LATER

REBUILDING OF 12-IN. BAR MILL

By JAMES O. DAGUE
Assistant Superintendent
Mechanical Department
Bethlehem Steel Co.
Lackawanna, N. Y.

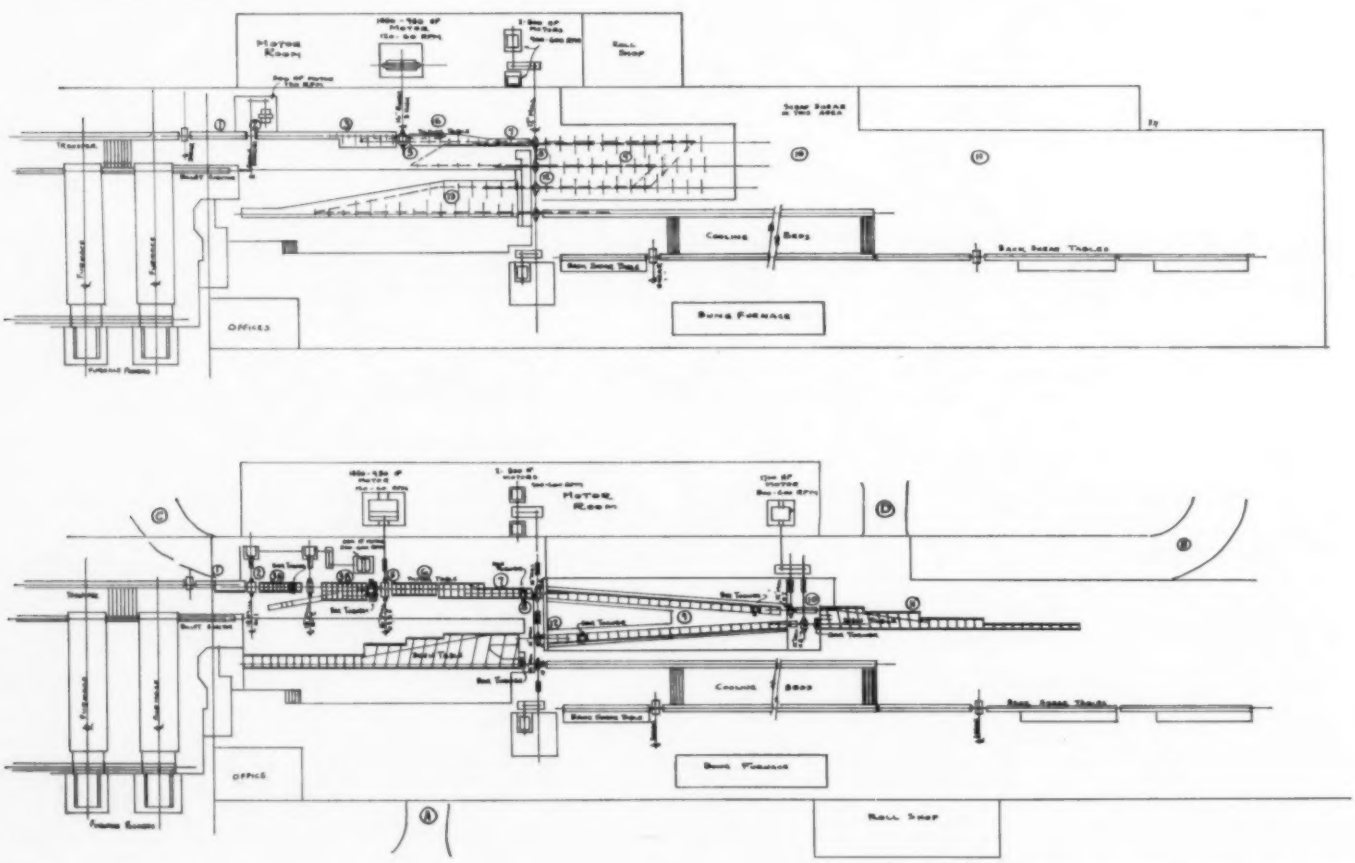
. . . . careful and detailed planning and much ingenuity were required to rebuild the mill in the limited time scheduled . . .

▲ TO comprehend the choice of methods used in rebuilding the 12-in. bar mill, an explanation must be given of the extent of the work to be done. The time of the job will also be given as a yardstick in measuring the effectiveness of the methods.

Figure 1 shows a composite drawing of the former and present arrangements of the mill. The former layout is at the top, the present at the bottom. A comparison of the old to the new, with enough detail of the changes to demonstrate the magnitude of the job, will be given, starting from the furnace tables, and following the line of flow of steel through the mills.

The section of table between the cut-off shear and former scale breaker, (1) on upper sketch, was 38 ft

Figure 1 — Upper portion of drawing shows former mill arrangement and lower portion shows present arrangement of 12-in. mill.



long and consisted of 23–16-in. diam rolls, 15 in. long on 20-in. centers.

This table was shortened by 4 rolls, or by 6 ft 8-in. In addition, the last 11 rolls toward mill were lengthened to 30 in. To do this, the drive side girder remained stationary, and the idler side was moved 15 in. only in the area to be widened.

This table was in excellent mechanical condition. It was therefore decided to salvage and alter the line shafts and line shaft covers, and to reuse the roll and line shaft gearing, with all bearings. New bottom ties were furnished for the widened section. No separators, or spacers were purchased. Existing separators were split on their center lines and a 15-in. insert was welded in place. To facilitate the welding and assembly, and to release critical crane service, the decision was made to remove the table and send it to the shop.

The drive and idler side table girders were staggered so that no two sections matched, and the sections of girders were not spliced together. The table was designed for assembly in place, and not for removal of all or any one section.

Before the mill shut down, on previous repair turns, the table girders were spliced. The table was also diagonally braced, so it could be removed and shipped as one unit.

In the shop, the necessary parts of the table were stripped and altered and the separators burned. Then the two separate girders of the widened section were lined and leveled. The lineshaft, longer rolls, covers and drive were assembled, while the girders were held by temporary bracing. Then the 15-in. insert was welded in the separators. This was done to prevent misalignment and resulting bind in the table.

While in the shop, all new sideguards and grease and oil lines were installed, and the table tested. It was braced and returned to the mill for installation as one unit. Section 1 on lower drawing shows the location of the altered unit. Figure 2 shows the arrangement of the finished table.

The foundation alterations to support the widened table were not extensive. Only the grout was removed from drive side girders; foundation bolts were saved. Under the 14 ft 0 in. section to be widened, the old piers were cut down 1 ft 0 in. and drilled for bonding pins. The piers on the relocated center were bonded into the old ones, and into the mat.

The former scale breaker, (2) on upper drawing, (Figure 1) was removed entirely. In its approximate location, the new 18-in. mill No. 1 was installed, (2) on lower drawing.

The foundation of the scale breaker was removed to the mat. It contained 87 cu yd of reinforced concrete. This foundation was the largest one to be removed.

The table between the former scale breaker and the 3-high, 16-in. roughing mill was altered in a similar manner to the No. 1 stand approach table.

The former table was 56 ft in length. It consisted of one 35-ft section of 22 rolls of 16-in. diam x 15-in. long, and a 21-ft section of 5 rolls of 16-in. diam x 60-in. long, separated by 8 rolls of 16-in. diam x 15-in. long. All rolls were on 20-in. centers.

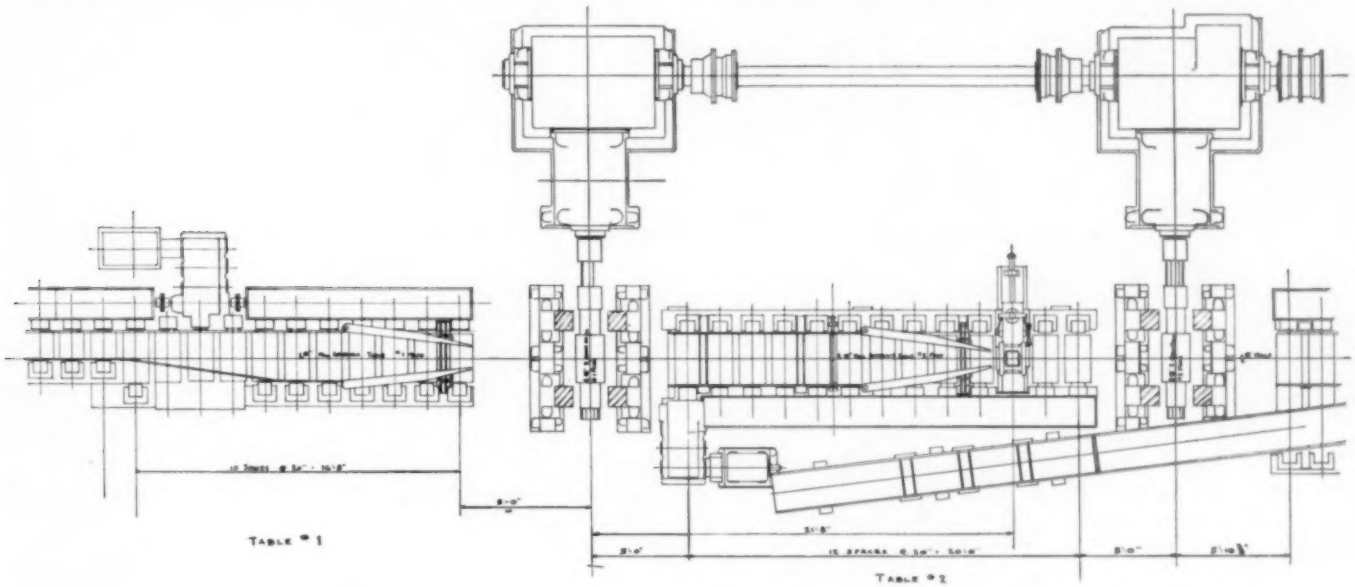


Figure 2 — Sketch shows arrangement of mill tables No. 1 and No. 2.

This table was spliced, braced, and removed to the shop in two sections for alterations.

The section of table between No. 1 and No. 2 stands, 3a on lower drawing, (Figure 1) was made of new girders, rolls, lineshafts and a new drive. The old table contributed the line shaft covers, gearing and bearings. The finished table was 22-ft long, consisting of 12 rolls of 16-in. diam x 30-in. long. The arrangement of the table is shown on Figure 2, Table No. 2.

This table was assembled complete in the shop, with sideguards, bar turner, and oil and grease lines. It was tested, braced and shipped as a unit.

The table between stand No. 2 and the former 3-high rougher, table No. 3b on lower drawing, (Figure 1) was altered from the old table, using exactly the same methods of widening and assembling as in table No. 1.

The result was a table 30 ft-7 in. long, consisting of 6 rolls of 16-in. diam x 72-in. long and 9 rolls of 16-in. diam x 60-in. long. The assembly is shown on Figure 3.

The foundation work on these tables duplicated that on No. 1 entry table.

The new 18-in. stand No. 2, (4) on lower drawing, (Figure 1) was installed between these two altered tables. Excavation for the foundation entailed removal of an oil cellar and concrete floor and fill totaling 120 cu yd.

The existing 3-high, 16-in. roughing mill, (5) on upper and lower drawings, was not to be altered. However, as a maintenance job, the mill and pinion housings were removed and sent to the shop for remachining. During shutdown, the mill shoes were regrouted. The old rougher is now known as 16-in. mill, stands No. 3, No. 4 and No. 5.

The former tilting table, No. 6 on both drawings of Figure 1 was not altered.

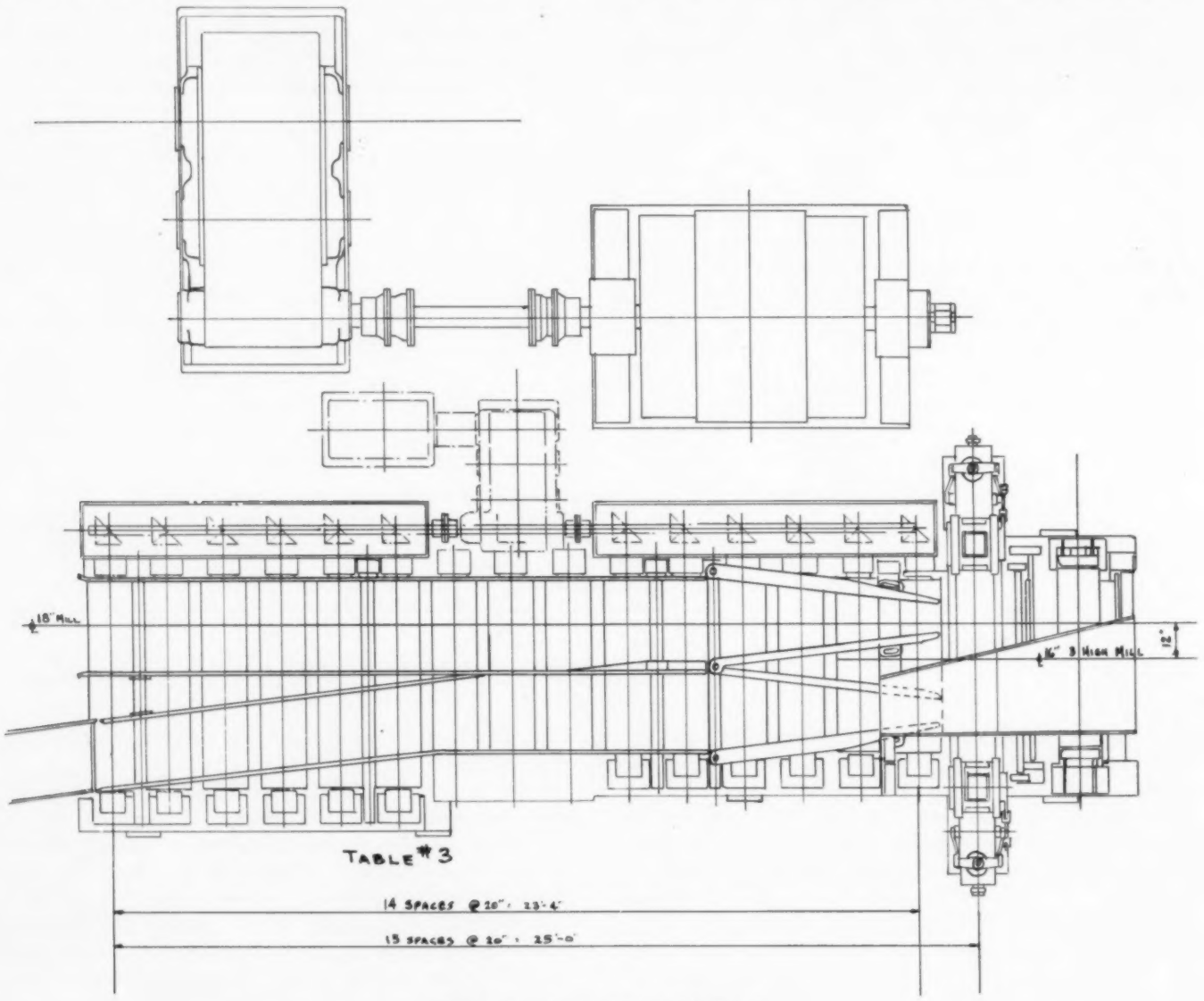


Figure 3 — Layout for table No. 3.

The approach table to the former 3-high, 12-in. mill, No. 7 on both drawings, was altered in identical manner to table No. 1, widening the rolls from 24 to 31-in. It was not changed except for widening. It became the approach table to the new 14-in. mill No. 6. The foundation work duplicated the excavation, doweling and forming of tables No. 1, No. 2 and No. 3.

The former 12-in., 3-high rougher and leader stands, No. 8 on upper drawing, were removed completely. Mill pinions were also removed. The drive shaft between pinions and motor was removed for shortening 1-ft-7-in., to allow for the longer pinion housing. Foundations were removed to the mat, 10 ft-5-in. below floor.

A monolithic foundation for the new 14-in. mill and pinions, and 12-in. pinions to drive No. 9 stand, was poured. New shoes, 14-in., and 12-in. pinions, and mill were installed.

All equipment to the east, or right on drawing, (Figure 1) of the former 12-in. mills was removed entirely and replaced by new No. 7 and No. 9 mill approach tables. This is shown as area No. 9 on drawings.

The equipment consisted of two tables of six driven and five idler rolls of 16-in. diam x 5 ft-0-in. long, 11 6-in. diam x 5 ft 0 in. long floor idlers, and chains, sprockets, drives, etc., for transferring the bars from one table to another. All floor plates and supporting beams were also removed.

Old foundations were left intact from the 12-in. mill a distance of 64 ft 0 in. east to "C" control house, which was under the concrete mill floor. Dowels were set in old foundations and mat, and piers for the new tables formed and poured.

Figure 4 — Beginning of excavation is shown in this view.

"C" control house roof, or mill floor, had to be removed entirely, for lowering. It was also necessary to strengthen the new roof to hold the heavier table loads. The roof to be removed measured 22 ft 6-¼ in. x 51 ft 0 in.

Installation of foundations and tables for 7 and 9 stands was complicated by the difference in elevation between new No. 6 and No. 7 stands. The difference was 12 in. This necessitated a table sloping upward from No. 6 to No. 7, with resultant different elevations of every foundation pier.

Table between No. 8 and No. 9 was level and thus presented no foundation difficulties. A finished concrete floor was poured in this area, in place of the discarded plates.

The area east of control house "C", to the right of the illustration, area 10 and 11 on drawing, was composed of mill floor and fill.

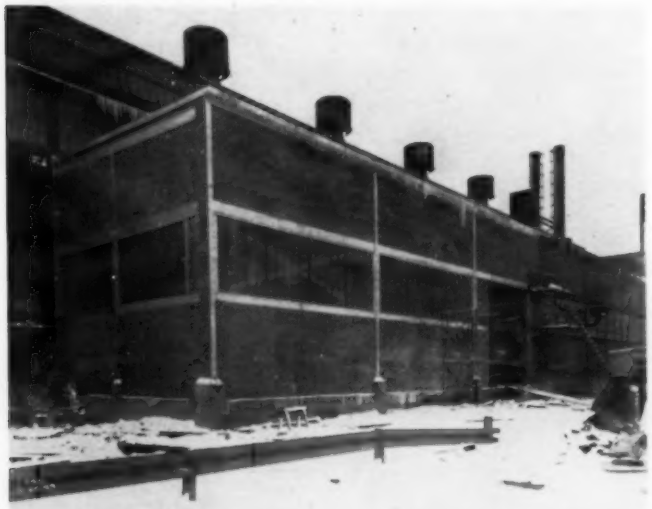


Figure 5 — It was possible to complete the motor room before the mill was put out of operation.

This was torn out and replaced by new 12-in., No. 7 and No. 8 stands, 10 on lower drawing (Figure 1) and a skew table from No. 7 to No. 8, complete with sideguards, bar turners, etc., 11 on lower drawing.

Being removed from operating territory, the necessary excavation and foundation work was done weeks ahead of the shutdown date. Similarly, the extension to motor room was completed in advance of shutdown by contractors.

Figure 4, dated 7/27/49, shows start of excavation. Figure 5, dated 11/28/49, shows completion of motor room. Figure 6, dated 12/28/49, shows forming of new No. 7-8 stands and of tables east of control room "C." Figure 7, dated 2/27/50, shows the mill-stands and skew tables installed, but not lined or grouted. The former 12-in. leader remained intact, No. 12 on drawing, (Figure 1) and is now known as stand No. 9.

All equipment west of 14-in.-12-in. mill and south of No. 1 through No. 6 stand tables, area to left and bottom of drawing, (Figure 1) was entirely removed and

Figure 6 — The foundations for the new mill stands are here shown.

replaced by a new No. 9 to No. 10 skew table, area 13 on drawing.

The equipment consisted of one 107 ft-4-in. long table of six driven rolls of 16-in. diam x 24-in. long, and 6-in. idler rolls of 6-in. diam x 24-in. long; one table of 144 ft length, consisting of nine rolls of 16-in. x 60-in. long; six idlers of 6-in. diam x 51-⅞-in. long and six idlers of 6-in. diam x 24-in. long; two transfers, complete with chains, drums, sprockets, etc.; all floor plates and supporting steel.

Figure 7 — Mill, stands, and skew tables have been installed but are not lined or grouted.

The floor plates presented a problem. There were 37 to be removed, stored, and replaced after alterations were completed under their locations, 85 to be removed, altered and replaced after installation of machinery, and 129 to be removed and scrapped. This entailed 251 crane lifts out and 122 back for floor plates only.

The foundation work in this area consisted of doweling into present piers and extending same, together with new piers to carry the added load.

From the center line of the 10-in. mill to the west, the new table supports were of steel, to clear the access tunnels and oil and hydraulic rooms. This area was 56 ft-8 in. x 7 ft-0 in. wide. Floor steel was heavy, columns being 8-in. WF @ 40-lb, and girders of 21 WF @ 82-lb.

Area between these girders was sheeted and a 4-in. concrete roof poured. No changes were made to mill No. 10 or to the remainder of the mill equipment.

SUMMARY OF WORK

After the preliminary contractor's work was completed, the work remaining to be done during shutdown was summarized.

1. 1250 cu yd of reinforced concrete and fill to be removed.
2. Four complete mills to be removed.
3. Seven mill tables to be removed, three to be altered into four new tables.
4. Three transfers to be removed.
5. All floor plates, supporting steel, pipe and conduit to be removed in an area 60 ft wide x 304 ft long.
6. Forming and pouring foundations containing 580.5 cu yd of concrete, 13,210 ft of reinforcing bar, and 408 foundation bolts ranging from ¾ to 2-½-in.
7. Installing seven new tables, two 18-in. mills complete with drives and motors; one 14-in. mill and pinions, one 12-in. pinion housing and one 16-in. mill and pinion housing.
8. Install all mill floors.
9. Rewire entire mill.
10. Pipe new installations and repipe old ones. Practically all conduit and pipe was removed with former equipment.

PROBLEMS

The shutdown time was to be of 21-day duration. To do the job in this time, the problems were analyzed as listed:

1. Only two cranes of 25-ton capacity to do all work.
2. One truck and one railway entrance to move material in and out.
3. Too much excavation and drilling for bonding pins in alloted time.
4. Necessity of sequencing operations to allow pipefitters and electricians, normally the last to finish, sufficient time to do work.
5. Foundation forms were too extensive to do in time, if normal sequence of excavating, and then forming, was followed.

METHODS

Crane—As a method of eliminating the problems of cranes, the decision was made to make only the most necessary lifts during the shutdown period. To this end, all new equipment was assembled before shutdown in the largest sections applicable. Tables were assembled in not more than four sections; mill pinions and drives were completely assembled.

No detailed alterations requiring crane service were done in mill. All equipment to be altered was shipped to the shops. Any necessary supports, as in the case of tables, were welded ahead of shutdown on previous repair turns.

During shutdown, there was always one person in command of crane priority 24 hours per day, so no move was wasted and the most necessary lift was given preference.

Entrances—It was physically impossible to move all the necessary rubble, concrete and equipment through the one truck door. Railway movements were considered to be too slow for the time allowed. The only truck entrance is shown on Figure 1 as A. In addition, an area was cleared and fill added to permit trucks to enter through finishing and into railway opening, B on drawing. A way was similarly cleared through billet yards into mill, C on drawing. This not being considered enough, a ramp was built and a section of wall removed to form a temporary entrance, D on drawing. As the job was done in cold weather, temporary wooden doors were installed at the opening. Materials were rigidly scheduled to different entrances. Concrete and rubble only at C, long, heavy loads at B, structural and plates in and out at A, and concrete and machinery at D.

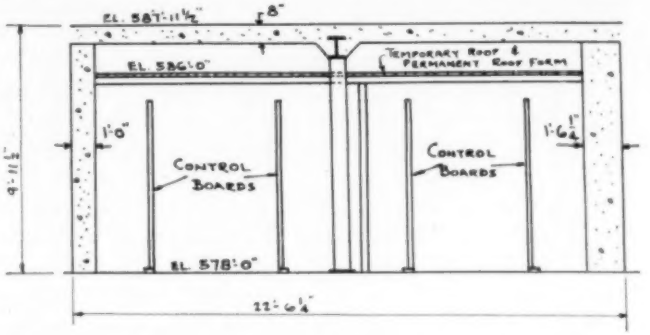


Figure 8 — A temporary roof was built to give protection to the switchgear and panel boards.

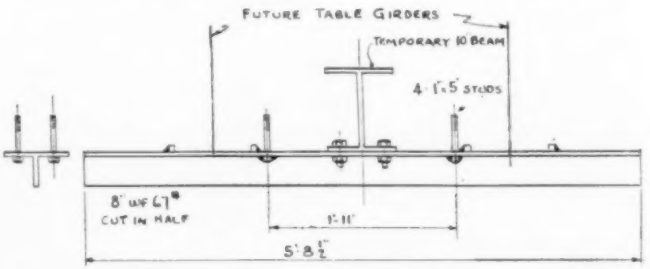


Figure 9 — The bottom shoe plate of the tables was bolted to a 10-in. beam.

Excavation—To help the excavation problem, all that was possible to do was done before shutdown. The mill operators agreed to run without the scalebreaker, the largest foundation to be removed, for one week prior to shutdown. No dynamiting could be done before shutdown, but men with jackhammers removed 80

Figure 10 — The 10-in. beams are being installed in this photograph.

per cent of this problem before the mill ceased operating.

The areas under the tables from No. 6 to No. 7, No. 8 to No. 9 and No. 9 to No. 10 were accessible from the basement. During operation, the notching and the doweling into present piers was completed.

Sequence—To help the pipefitters and electricians, a sequence of installation priority was drawn up, planning to install the units first with the longest electrical and pipe time. For example, all crafts were aimed at installation of No. 1 and No. 2 stands first, and the foundations at C control house.

Of the utmost importance to the electricians was the restoration of the roof of C control house, so existing equipment could be rewired. This area was therefore given split preference with the area of No. 1 and No. 2 stands.

To protect the switchgear and panel boards, it was decided to build a temporary solid protection under the present roof. This idea was further developed and culminated in the installation of the permanent form for the new ceiling over the panel boards on the two repair turns preceding the shutdown. Figure 8 shows the detail of the installation.

This method allowed uninterrupted work for the electricians in the control house from the moment of shutdown. After shutdown and removal of table equipment, the ceiling was chipped out, exposing the new form all set for pouring.

The foundations for No. 6 to No. 7 and No. 8 to No. 9 tables passed over this control house. To eliminate the pouring of the various piers to their different elevations, as previously described, it was decided to bolt the bottom shoe plate of the tables to a 10-in., 57 lb beam. These beams were made of spliced 80 ft-0 in. sections. They were aligned and leveled to the slope of the finished table foundations. When concrete was poured to the bottom of the beam, the foundation was ready for assembly of the tables. No further alignment or grout was necessary. Figure 9 shows a cross section of this detail. Figure 10, dated 3/18/50, 48 hours after mill was down, shows the start of installation of these beams. The workmen in picture are on top of "C" control house.

Forming—In the foreground of this picture, (Figure 10) is an example of the methods used in forming. To lower the time of the job, it was decided to form in advance every pier possible. The forms pictured were installed before the mill was shut down. They were carried by hand under the existing tables and set, after doweling and roughing the present piers. Except for setting the foundation bolts, they are ready to pour.

Similarly, it was decided to have all the major forms, such as for mill foundations, ready to pour when the mill was shut down. This meant prefabricating. Sites were cleared in unused sections of the mill and assembly started two weeks before the shutdown dates. The main items handled this way were the foundations for No. 1, 2 and 6 stands.

Figure 11, dated 3/15/50, was taken the day before the mill was shutdown. It shows the complete form for the 18-in. mill stand No. 1. In the left background are the furnace stacks. This form contains all foundation bolts and conduit. All dimensions are set from two reference lines, one of which can be seen at top of form. Thus, when excavation was completed, the form was raised by crane, lowered into place, aligned by engineers to correspond with present reference lines, braced,

Figure 11 — Some forms were completed prior to the time that the mill was shut down.

Figure 12 — Side view of form shown in Figure 11 is here given. This form is for stand No. 1 of the 18-in. mill.

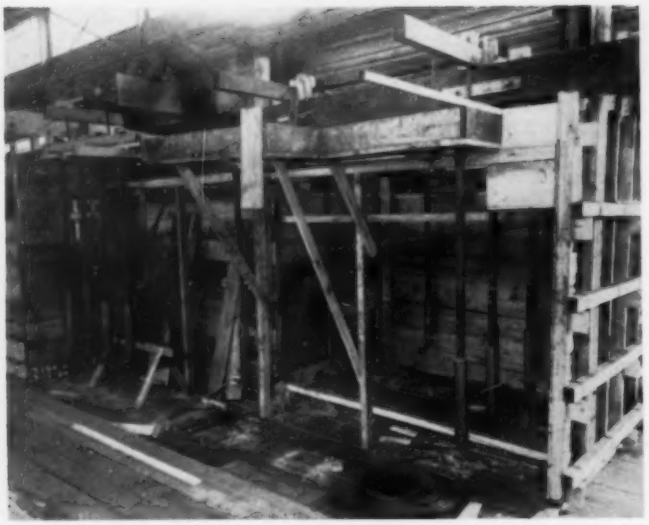


Figure 13 — Method of setting up foundation bolts is illustrated here.

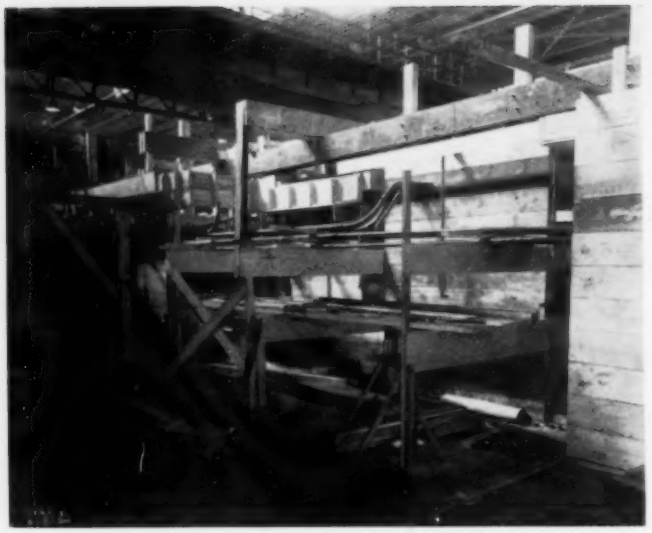


Figure 14 — Conduit was also installed in the forms.

reinforced and poured. The time from finish of excavation to finish of pour was less than eight hours. It was estimated that this method saved at least seven days time. The size of the men in comparison to the form gives an idea as to its size. This form weighed 16 tons, without reinforcement. Figure 12, same date, shows a side view of the form for No. 1 stand.

The largest prefabricated form was that of the 18-in. mill, No. 2 stand. Incorporated with it were the foundations for the reduction gear and motor. The finished form weighed 23 tons. It was handled into place by riggers. The carpenters built it, but did not want to handle it.

Figure 13 gives a good view of some foundation bolts for stand No. 2. Figure 14 shows a run of conduit being installed. Figure 15 shows a preformed section of mill sewer attached to No. 2 stand.

Figure 16 shows one of these large forms, No. 1, immediately after lowering into place. It was braced, and poured at once. Note that the date, 3/18/50, is only two days after the mill shutdown.

Figure 17 shows a rather small one of these forms being transported by crane to its location. This one weighed only 5 tons. It is a combination form for the foundations of the No. 6 stand, 14-in. pinion and mill, and the 12-in. pinion for stand No. 9. This form was left for the last because there was little electric and pipe work necessary to complete it. Figure 18 shows it being lowered in place. In background can be seen the installation of No. 6 to No. 7 table, five days after start of job.

The most important "method" of the entire job was the sequencing of the different crafts and operations to insure that first things were done first, and that there would be no confusion of too many men in the same location.

To accomplish this, a lineup of the entire job was mimeographed, which listed the key jobs and the potential trouble spots. This was passed out to the foreman of all departments concerned. Then a "blackboard" session was held to explain the lineup. A composite print was made up, from which to explain the details.

The job was explained step by step, so there could be no misunderstanding. This meeting was held three days before shutdown.

After shutdown, there was always one man on every turn to insure that the predetermined sequence was adhered to. Nothing was permitted to interfere. This

Figure 15 — A section of the preformed sewer is shown attached to No. 2 stand.

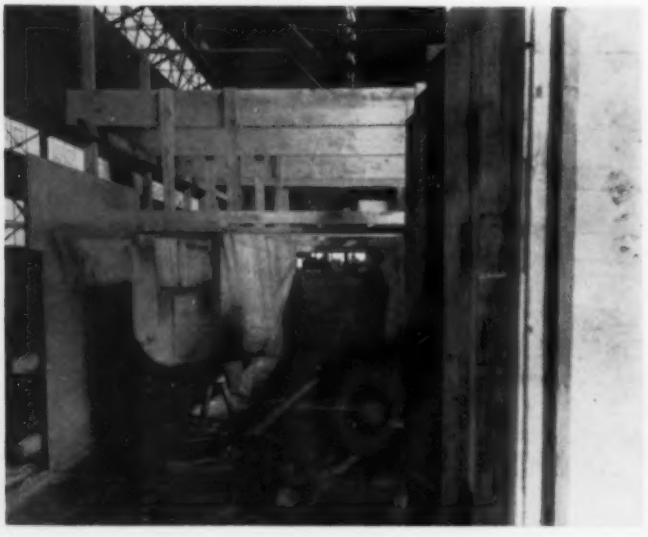


Figure 16 — Form for stand No. 1 has just been lowered into place. It was possible to pour very quickly after form was set into place.

Figure 17 — Form shown here being carried by crane weighed about five tons.

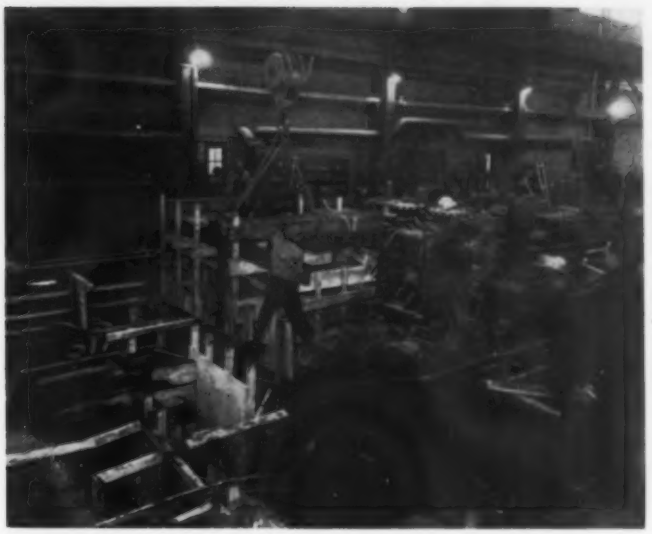


Figure 18 — Form illustrated in Figure 17 is shown in this illustration being lowered into place.

man controlled the priority of cranes and trucks, and controlled the work priority to favor the craft that was lagging.

In case of necessity, priorities were altered daily to conform to field conditions.

TIME

Some of the times of the job have been noted on the pictures. To prove the value of the methods, a general outline of the key times will be given. Originally, the job was estimated by contractors as requiring 60 days. Due to pressure of orders, management requested that it be attempted in 21 days.

The mill shut down March 16 at 7 a.m. and started again on April 1, at 7 a.m. A brief summary of key times follows:

The mill, including tables to go to shop, was completely dismantled by 3/19/50. No. 1 stand was poured 3/18; C control house roof and foundations for No. 7 and No. 9 tables 3/19; No. 2 stand 3/21; No. 6 stand 3/22. All foundations were poured by 3/25; all finished floors by 3/28. No concrete was poured after 3/28.

Installing new floor steel and plates, and altering old ones started 3/16, completed 3/28/50. No. 1 mill was installed 3/22; No. 2 by 3/24; and No. 6 by 3/25. No. 3 mill, 16-in. rougher, and pinion were removed 3/20, reinstalled 3/28. No. 6 to No. 7, No. 8 to No. 9, and No. 9 to No. 10 skew tables were installed from 3/19 to 3/27/50. No. 7 and No. 8 stands, with motor, were completed 3/23; altered mill tables one through six were completed 3/25; all grouting was completed by 3/27. Temporary truck opening was closed 3/26, being no longer needed.

The time between 3/27 and 4/1 was spent in piping, wiring, and in installing walkways, guards, and miscellaneous equipment.

Figure 19, dated 3/30, shows a view of the mill looking from No. 1 stand. Mill is ready mechanically except to put in spindles. These were left out until last to permit testing of motors and drives.

Figure 20, dated 3/30, shows a view of No. 8, 9, and 10 stands, looking east. As in Figure 19, the spindles are left out to permit testing. The mill was put into operation two days later, on April 1. Time from steel to steel was 16 days.

Figure 19 — Mill is now ready mechanically except for installation of spindles.

Figure 20 — General view of No. 8, No. 9, No. 10 stands looking east.

COMPARATIVE INVESTMENT COSTS FOR DIFFERENT STEELMAKING PROCESSES

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. . . . a condensation of paper presented at United Nations Latin American Working Group Meeting, Iron and Steel Conference, Bogota, Colombia, October 21-22, 1952 . . . . relative capital investment requirements are given for twenty-two different hypothetical meltshops . . . .

▲ THE subject matter of this paper — a study of the relative capital investments required to make steel by different processes — was suggested by the United Nations Secretariat. Since we had recently made a detailed study of the economics of steelmaking by the open hearth as compared to the basic electric furnace process, the extension of our earlier work to cover other processes seemed likely to yield further information of considerable general interest. At the further suggestion of the Secretariat, the study was broadened to include figures for plants of several different sizes to show the effect of plant size on investment cost per unit of capacity. Besides developing tentative general layouts for plants of four different capacities for each of the six processes considered, a host of related items had to be considered; furnace and equipment capacities had to be determined, numerous engineering approximations — sometimes known as informed guesses — made, and many simplifying assumptions agreed upon, before we were in a position to arrive at the cost estimates which form the basis of this paper.

Originally we had hoped to be able to make our comparisons on the basis of actual capital cost figures for existing steelmaking plants of various types and sizes, but this turned out to be a very unsatisfactory method of approach. To cover all the processes meant that figures from more than one country would have to be used and really comparable cost figures from separate countries are very difficult to obtain because of differences in accounting practices, especially as to what costs should be included and what left out — as well as the influence of inflationary changes since, and even during, their construction. And this is not to mention the effect of diverse local political conditions, and whether a given plant was built on the basis of relatively limited private means or with ample government funds. In the end, we decided that the only way to do the job properly, was to estimate separately the actual building and equipment requirements of each size plant for each one of the six processes — and then to arrive at the desired overall plant estimates from the sum of the parts required in each case.

While we believe the estimates reported herein give a valid comparison between different steelmaking processes from the capital investment cost point of view, and thus we hope will be found to be of considerable general interest, they certainly should not be used as the principal basis for favoring one type or size of steel plant over another. The factors involved in deciding on the most suitable process and layout for a new steel plant are so numerous and varied, that the best solution — i.e., the one that takes all factors into account, including the magnitude of the funds available — is usually arrived at only after many alternatives have

been analyzed, compared, and discussed at length from the differing viewpoints of all parties concerned.

SCOPE OF THE WORK

The whole reason for this paper lies in the plant capital investment cost estimates which it gives for twenty-two different types and sizes of steelmaking plants or "meltshops." The annual capacities of these plants are grouped into four sizes, for the production of 100,000, 250,000, 500,000 and 1,000,000 metric tons of ingots per year. The six different processes covered are listed below:

1. *The acid bessemer process* — with auxiliary electric furnace capacity for melting the home or plant scrap, plus a small amount of purchased scrap.
2. *The basic bessemer process* — also with electric furnaces for melting scrap.
3. *The basic open hearth process* — based on the use of stationary furnaces.
4. *The basic electric furnace process* — based on the use of top charge electric furnaces.
5. *The acid bessemer-basic open hearth duplex process* — based on acid bessemer converters and tilting basic open hearth furnaces.
6. *The acid bessemer-basic electric furnace, duplex process* — based on acid bessemer converters and basic electric furnaces.

LIMITATIONS OF THE ESTIMATES

As indicated, the twenty-two plant capital investment cost estimates were not derived from any existing steelworks investment cost figures, but were developed on the basis of separate unit building, equipment, and erection costs. They apply purely to the twenty-two hypothetical steel plants. The estimates thus cannot be said to represent any actual plants — an obvious disadvantage.

On the other hand, the results derived from the method employed probably afford considerably more accurate comparative figures for the different size plants and processes studied than could possibly be obtained from the original costs of various actual plants, since actual plants would of necessity have been built at different times, for different clients, in different countries, and therefore under anything but comparable conditions. Our figures on the other hand, are all based on the same methods of calculation and estimation throughout.

Most of the building estimates were based on free-hand sketches, developed only in sufficient detail to give the proper number, length and width of the various buildings required to house the furnaces and other equipment and facilities needed by each plant. The size and number of these were separately developed by a study of the metallurgical and operating requirements of each one of the twenty-two cases.

GENERAL CONSIDERATIONS

All the figures given are based on plants designed for Latin American conditions. Due to the general scarcity of scrap in Latin America, the assumption was made that each meltshop would be part of an integrated steelworks having sufficient pig iron capacity to supply the full amount of hot metal each meltshop needed for its annual output. A small supply of outside purchased scrap, taken equal to 10 per cent each plant's ingot capacity, was assumed to be locally available in addition to the plant's internal mill or home scrap. All the rest of the metallic charge going into the steelmaking furnaces would be molten pig iron or "hot metal." Presumably, in most cases this would come from blast furnaces of appropriate size, except that in some of the smaller plants it could also come from electric pig iron furnaces.

A meltshop capital cost estimate customarily includes a full complement of ingot molds and cars for initial operation of the plant. Before their number and cost can be estimated, the ingot size for each plant must be established. The ingot size in turn is largely determined by the requirements of the rolling mills, and the size and type of the latter are set by the products to be rolled. Some assumptions therefore had to be made as to the kinds of products that were to be rolled from the ingots poured in our hypothetical meltshops.

The products to be rolled of course depend upon the local market. To have a common basis to work on, it was assumed that all twenty-two meltshops would be part of the first integrated steelworks to be built in that section of the country. This made reasonable the further assumption that the finished steel product mix would be roughly the same in all cases, i.e., reinforcing bars, wire rod and hot rolled (hand mill) sheets in the case of the smaller 100,000 and 250,000-ton plants with the addition of structurals, rails and an increased proportion of flat rolled products — plate, sheets, tin plate and welded pipe — in the case of the half-million and million ton plants.

Nothing is included in any of the estimates for the cost of land. Under Latin American conditions, however, it was taken for granted that plant sites of ample size would be available. This factor influences plant layout, since in the case of the basic bessemer plants, for instance, it permits the use of separate buildings where conventional European practice, due to space limitations, would be more likely to concentrate several different operations under one roof. While the more compact European design would perhaps permit some reduction in initial investment cost, it would certainly interfere with the large scale future expansion of the plants normally to be expected in Latin America. An attempt was therefore made to lay out all our hypothetical plants so that they could be enlarged in the future as the country's steel requirements rose.

METALLURGICAL CONSIDERATIONS

While the cost per ton of capacity of a new meltshop is an important point in the choice of the best steelmaking process for a new project, it must be remembered that in many cases the analysis of the raw materials available is likely to be the deciding factor. Also, while the meltshop is a most important department of an integrated steel works, it normally only accounts for from 8 to 14 per cent of the total investment required to build a complete integrated steel works.

The composition of the available raw materials is such an influential factor in the selection of the steelmaking facilities to be used in any given case, that we propose to review the subject briefly here.

Case 1. *The acid bessemer process* — For pig iron to be suitable for the acid bessemer process, its phosphorus content must not exceed a maximum of approximately 0.080 per cent. The phosphorus content of pig iron in most cases is determined by the amount present in the iron ore used since the majority of coals are relatively low in phosphorus and some source of low phosphorus limestone can usually be found without too much difficulty. On the other hand, the supply of low phosphorus iron ore throughout the world is relatively limited, although Brazil and Venezuela have vast quantities of this grade of ore and lesser deposits are known to exist in other Latin American countries.

Since acid bessemer steel is more difficult to fabricate than basic steel for many uses, it suffers under a considerable sales disadvantage, the steel industry being a highly competitive one. Because of this, no estimate for a million ton acid bessemer plant was included in our study.

Since the scrap melting capacity of the bessemer process is limited, electric furnaces were provided in all the bessemer plant estimates, not only for melting the home mill scrap, but also the 10 per cent of outside purchased scrap which was assumed in all cases. The resultant electric furnace ingots would provide an appreciable tonnage of low phosphorus steel for some of the products for which acid bessemer steel is not suited.

The superior qualities of basic steel have also made acid bessemer steel non-competitive except for a limited number of more or less special products, such as high sulphur screw stock and skelp for butt welded pipe.

Should an individual country desire to do so, it could undoubtedly satisfy the great majority of its steel requirements with acid bessemer steel, especially if the steel from the 25 per cent or so of all scrap electric furnace heats were reserved for those uses for which acid bessemer was definitely unsuitable. In the face of international competition, however, with acid bessemer steel excluded from the generally accepted specifications for such major products as rails and structurals as well as many flat rolled uses, it would be practically impossible to dispose of a large output of it for those uses unless the use of other types of steel for such products were embargoed or otherwise regulated.

Case 2. *The basic bessemer* — As in the case of the acid bessemer process, whether the basic bessemer can be used at all or not in a given instance, is primarily dependent on the composition of the available iron ore. This is true, at least in the present state of development of basic bessemer practice, since pig iron suitable for conversion into steel by the normal air blown basic bessemer process must contain a minimum of from 1¾ to 2 per cent of phosphorus. Oxygen enrichment of the blast is expected to make the handling of lower phosphorus content metal possible in the future however; in fact, this has already been proved to some extent in actual practice. In basic bessemer plant capital cost estimates, this currently changing situation was taken into account by providing an oxygen plant in all cases with sufficient capacity to enrich the air blast going to the converters up to 30 or 35 per cent oxygen.

It is probable that the use of 30 to 35 per cent oxygen in the converter blast would permit pig iron containing as little as 1½ per cent of phosphorus to be used. Theoretically, with still higher oxygen enrichments, even lower phosphorus contents should be feasible. Up to the present time all attempts to use very high oxygen enrichments or pure oxygen have always resulted in very rapid destruction of the lining of the basic converter vessels, especially the bottoms, due to the extremely high local temperatures developed. The resultant high refractory cost combined with greatly reduced vessel availability have made it completely uneconomic.

In contrast to the finished product situation described in the case of acid bessemer steel, we have assumed, in setting up our figures, that steel made by the basic bessemer process, particularly with an oxygen enriched blast, would be comparable in quality to that made by the open hearth and therefore metallurgically suitable for the entire range of steel products.

The basic bessemer plants require a greater number of auxiliaries than acid bessemer shops. These include facilities for burning lime and dolomite, and a special plant to prepare the high phosphorus basic bessemer slag for use as fertilizer. Such slag is widely used in western Europe for agricultural purposes, and the income from its sale represents an important credit to the cost of producing basic bessemer steel.

Case 3. *The basic open hearth* — More of the world's steel is made by this process than by any other, primarily because most of the steel produced in North America is basic open hearth steel. One of the main reasons why the open hearth process replaced the bessemer process in the United States was that, unlike the bessemer, it proved able to make steel from scrap as well as from pig iron, and as the country became more highly industrialized, scrap became increasingly plentiful. In addition, the bulk of the iron ore on the North American continent had a relatively low phosphorus content, much too low for the basic bessemer process, but too high on the other hand on the average for the acid bessemer. Due to its ability to handle phosphorus contents up to 1 per cent and to make steel from any and all proportions of scrap and pig iron, the basic open hearth process became, and still is, by far the most popular method of producing steel in North America.

Case 4. *The basic electric furnace* — While up to the present time the basic electric furnace has been used largely for scrap melting, during the past few years thousands of basic electric furnace heats have been made successfully in the U.S.A. from charges containing up to 40 per cent or more of hot metal and there is apparently no reason why the refining of substantial amounts of hot metal in the electric furnace should not become a more widely spread practice in the future.

Due to the necessarily oxidizing nature of the combustion reactions taking place in an open hearth flame, blast furnace hot metal can be charged to an open hearth furnace in amounts up to 60 to 65 per cent of the total metallic charge before it begins to have an adverse affect on the overall heat time. In the electric furnace, on the other hand, the limited information available at the present time seems to indicate that when the amount of hot metal exceeds 40 to 50 per cent of the total charge, heat times tend to lengthen and the productive capacity of a given furnace unit begins to

taper off. This has been allowed for in arriving at the size and number of electric furnaces required for the different size electric furnace plants in our capital cost estimates.

Cases 5 and 6. The duplex processes — The influence of raw material composition, particularly as regards phosphorus content, on the selection of the steelmaking process to be employed in a given case has already been seen to be of primary importance in the case of the two bessemer processes. If the phosphorus in the ore is low enough, the acid bessemer process is technically feasible, while with a very high phosphorus ore, the basic bessemer process is not only feasible, but practically mandatory, since both the basic open hearth and the basic electric furnace processes have increasing difficulty in eliminating phosphorus after its percentage in the pig iron begins to exceed 0.500 per cent, and these processes are not used at all to any extent so far as we know, when the phosphorus content in the hot metal exceeds 1 per cent.

In cases where the phosphorus in the pig iron is too high to be readily handled by the basic open hearth or electric furnace processes, but still not high enough for the basic bessemer, i.e., where the making of two slags for proper dephosphorization is required, present metallurgical thinking tends to favor the acid bessemer — basic open hearth duplex process. The possibility of duplexing therefore needs to be considered primarily in those cases where the available iron ore would yield a pig iron with a phosphorus content of between three-quarters and one and a half per cent. To help simplify the handling of the two slags per heat normally required to refine such relatively high phosphorus metal down to the low limits of finished steel products, duplexing is usually carried out in tilting rather than stationary open hearth furnaces.

Scarcity of scrap, coupled with the availability of fairly high phosphorus hot metal, therefore favors the use of duplex practice. While duplexing from the acid bessemer into the basic electric furnace has been known for at least 30 years, it has never become a very common steelmaking method, even though the fact that the electric steel furnace is normally a tilting unit would naturally be in favor of its use for this purpose. Since it was felt that the modern electric furnace was well suited for duplexing, particularly in a small plant, we included figures for it in the estimates.

Other steelmaking processes — The six conventional steelmaking methods for which plant capital cost estimates are given by no means cover the full range of possibilities, but there had to be some limit to the number of processes studied. No consideration, for instance, was given to the fact that in English practice, heated mixers, which perhaps might be considered as half-way between a normal pig iron mixer and a tilting open hearth furnace, are used in a number of plants to pre-refine blast furnace hot metal before it is charged into the open hearths.

Another recently developed practice for the conversion of pig iron into steel, which is about to be used on an industrial scale in Austria, is the use of a high pressure oxygen jet blowing from above down into a charge of molten pig iron held in a sort of closed bottom bessemer vessel. Too little is known about this process for any figures to be given here. Nor was any consideration given to basic bessemer duplex possibilities, it being assumed that with an oxygen enriched blast steel of a quality comparable to that produced in the open hearth furnace would be made directly in the basic bessemer, without the need of duplexing. On the other hand, while oxygen plant facilities were provided for enriching the basic bessemer air blast, none was provided in the acid bessemer estimates. In the other four cases, small oxygen plants were included with sufficient capacity for lance decarburizing of the bath in the furnaces, but no more.

The above brief discussion of a few of the more important metallurgical factors influencing the choice of steelmaking processes, has been given, as mentioned earlier, to emphasize the fact that the process showing the lowest cost in our plant estimate tabulations is by no means necessarily the best process for a given new project.

ENGINEERING AND TECHNICAL ASSUMPTIONS

As indicated earlier, overall plant metallic balances were first calculated for all twenty-two different hypothetical plants in order to establish the relative amounts of scrap and hot metal required in each case, and these figures in turn were used to fix the number and size of melting units needed. To simplify matters, a 70 per cent yield of finished products from ingots was assumed throughout, and the amount of plant scrap returned from the rolling mills for remelting was set at 23 per cent of ingot production. In actual practice both of these figures would vary somewhat with ingot size, type of rolling mill and heating furnaces, and especially with the kind of finished products made.

In setting up capital cost estimates, certain general assumptions were made as to the size of ingots, availability of power, ingot pouring practice, limiting number and sizes of melting units, etc.

In the case of the rolling mills, it was assumed that all plants of the same size would have the same type, number and size of mills, regardless of which steelmaking process the plant was designed for. For the smallest size plants, i.e. those with a capacity of 100,000 tons of ingots per year, a small 3-high mill was assumed capable of rolling ten-inch, 700-kilo ingots into billets and sheet bar. For the 250,000-ton per year plant, a small 2-high bloomer was supplied and the billet and sheet bar mill expanded so as to roll some medium structural shapes. This plant would cast sixteen-inch, 1700-kilo ingots.

For the half million-ton plant, a somewhat larger 2-high bloomer was assumed, together with a single stand reversing hot mill for rolling strip steel directly from ingots. Three-ton, 20-in. ingots were assumed for all the half million ton plants, with slab ingots of the same weight for the reversing strip mill. The 1,000,000-ton plant was provided with a combination blooming-slabbing mill and a semi-continuous strip mill. It was assumed that the meltshop would cast eight-ton ingots, either 30-in. square or equivalent slab sizes.

The above ingot sizes were chosen on the basis that the rolling mills provided would be able to roll the required annual ingot tonnages in 15 to 18 turns a week,

at the rate of 15–20 ingots an hour. As already mentioned, the same size ingot was assumed for all plants of the same size, regardless of the steel melting process. In actual practice this would probably not be true; ingots of more than one size would undoubtedly be poured in the larger plants, and they would probably not have the same dimensions in the case of all six processes.

The number of steelmaking furnaces in each plant was fixed on the basis of overall plant metallic balances. In the case of the straight acid and basic bessemer plants, sufficient supplementary melting capacity was provided to melt both the 23 per cent plant scrap as well as the assumed 10 per cent of purchased scrap. It was assumed that only a relatively small amount of scrap would be melted in the vessel of the acid bessemer. In the case of the basic bessemer plants, on the other hand, due to the fact that the use of an oxygen enriched blast was contemplated in all cases, it was assumed that 15 per cent of scrap, based on the total bessemer metallic charge, would be melted in the converters. Fifteen per cent may be a somewhat convervative figure, but we did not feel justified in using a higher percentage in the present state of the use of oxygen in basic bessemer practice. Electric furnace capacity was then provided to melt the remaining or surplus scrap.

In general a minimum of three open hearth units or two electric furnaces was assumed in all examples so as to provide a reasonably constant ingot output during necessary furnace outages. In the smallest size plant, however, providing three units would have meant using open hearths of only 43-ton capacity. These were thought to be too small for good practice under modern conditions, so two 65-ton furnaces were provided instead.

For each size plant and steelmaking process, we tried to lay out the individual meltshops so that, while they would be as modern and efficient as possible, they would not be overly elaborate or expensive under our assumed Latin American conditions.

In the smallest size acid bessemer plant, two or three-ton bessemer units could theoretically be used. However, we decided to use a minimum converter size of 10 tons of finished steel per blow or heat, so as to improve the yield and avoid having to pour an excessive number of heats. With two 10-ton vessels and a single blower, the requirements of the 100,000-ton plant can readily be met by operating one shift per day, six days per week. Similarly, in the case of the quarter and half million ton plants, somewhat smaller converters than those chosen could have been used by operating more shifts per week, but this again would have unduly increased the number of heats to be handled, so that two-turn operation with larger vessels was chosen as representing better, more economical steelmaking practice.

In the case of the million-ton plant, seven 215-ton open hearths were selected instead of five 300-ton units to hold down the capital cost of buildings and cranes. On the other hand, in selecting the furnaces for the million-ton size electric furnace plant, twenty-two foot diameter units, the largest now operating in the U.S.A., were used. Six furnaces of this size should easily accommodate the 106-ton high hot metal practice heats necessary to produce a million tons of ingots per year. The 106-ton figure is based on an average melting rate of 4½ heats per day. When melting 100 per cent cold scrap charges, i.e., in the case of the auxiliary melting units provided for the various acid and basic bessemer plants, a somewhat higher melting rate of five heats per day was assumed.

In connection with the supply of power to the meltshops — especially in the case of the electric furnace plants — it was assumed, since they were to be part of an integrated steel plant operation in all cases, that a substantial amount of electric generating capacity would necessarily be available from the blast furnace power stations. Although it was recognized that a somewhat larger generating capacity might be necessary to cover the added plant power requirements for electric furnace melting, no allowance was made for this in the electric furnace estimates. Not only would it have been difficult to estimate this accurately, but if the steelworks happened to be so located that it could be readily connected to a large hydro-electric or other public power system, the small amount of additional plant power required for electric melting could be purchased, in which case no increase in the steel works capital cost would be necessary at all.

Furthermore it must be remembered that an electric furnace operation based on a 60 per cent hot metal charge and using high grade Latin American decarburizing ore plus oxygen for working the heats would consume appreciably less power than conventional North American all-scrap charge electric furnace practice. The omission from the electric furnace estimates of anything for the cost of added power generating capacity was partly compensated for by providing a separate sub-station with sufficient capacity to supply the full requirements of the furnaces from an outside source of high voltage power.

The possibility of teeming steel into ingot molds placed on stationary plates in the pouring pit versus the use of ingot mold cars, or "pouring on wheels," was given some consideration. Our conclusion was that while pouring on plates, with the resultant handling of all ingots and molds in the pouring pit, was feasible for small productions up to perhaps 75,000 tons per year, pouring on cars would probably be preferable in most cases for larger plants. Although ingot outputs up to 250,000 tons do not justify provision of a separate stripper building, pouring on cars permits the ready removal of the ingots and molds from the pit side pouring platforms to a separate stripping area. This can be at one end of the pit in an extension of the pouring bay. With the molds on cars all mold preparation work can be done here, or kept out of the pouring pit entirely if desired.

The pouring of billet size ingots was also seriously considered in the case of the 100,000-ton plants but was discarded because of the need of being able to roll sheet bar for the production of hot rolled and galvanized sheets, two types of steel products likely to be of importance for any new integrated plant. Since the old hand hot mill method is still the only feasible way of rolling a limited tonnage of sheets in small plants designed primarily to roll bars and rods, the ingot size cannot be reduced below that permitting the rolling of sheet bar; 10 in. is about as small as it is feasible to go.

It will be noted that Table I shows the exact calculated sizes of the heats to be made by the major furnace units in the various cases, rather than just rounded off

TABLE I

Number and Size of Major Furnace Units

Four Different Plant Capacities and Six Different Steelmaking Processes

Steelmaking Process	Assumed Total Annual Plant Capacities (Metric Tons of Ingots Per Year)			
	100,000 Tons	250,000 Tons	500,000 Tons	1,000,000 Tons
1. Acid Bessemer				
a. No. and capacity of acid bessemer converter vessels. b. No., shell diameter, and heat size of auxiliary scrap melting electric furnaces (top charge).	Two 10-ton converters One 13-ft electric furnace tapping 17.3 ton heats	Two 15-ton converters Two 14-ft electric furnaces tapping 22.7 ton heats	Two 15-ton converters Two 17-ft electric furnaces tapping 42.5 ton heats	omitted
2. Basic Bessemer				
a. No. and capacity of basic bessemer converter vessels. b. No., shell diameter, and heat size of auxiliary scrap melting electric furnaces (top charge).	Two 10-ton converters One 11-ft electric furnace tapping 10.3 ton heats	Three 11-ton converters Two 12-ft electric furnaces tapping 13.0 ton heats	Three 22-ton converters Two 14-ft electric furnaces tapping 26.1 ton heats	Three 44-ton converters Two 18-ft electric furnaces tapping 31.8 ton heats
3. Basic Open Hearth				
a. No. and capacity of stationary basic open hearth furnaces.	Two 65-ton open hearth furnaces	Three 118-ton open hearth furnaces	Four 182.3-ton open hearth furnaces	Seven 215-ton open hearth furnaces
4. Basic Electric Furnaces				
a. No., shell diameter, and heat size of top charge electric furnaces.	Two 16-ft electric furnaces tapping 33.0 ton heats	Two 20-ft electric furnaces tapping 81.8 ton heats	Four 20-ft electric furnaces tapping 81.2 ton heats	Six 22-ft electric furnaces tapping 106.7 ton heats
5. Duplex-Acid Bessemer — Basic Open Hearth				
a. No. and capacity of acid bessemer converter vessels. b. No. and capacity of tilting open hearth furnaces.	omitted	Two 25-ton converters Three 70-ton tilting open hearth furnaces	Two 25-ton converters Three 144-ton tilting open hearth furnaces	Three 30-ton converters Five 176-ton tilting open hearth furnaces
6. Duplex-Acid Bessemer — Basic Electric Furnace				
a. No. and capacity of acid bessemer converter vessels. b. No., shell diameter, and heat size of top charge electric furnaces.	Two 12-ton converters Two 14-ft electric furnaces tapping 22.3 ton heats	Two 20-ton converters Two 18-ft electric furnaces tapping 53.2 ton heats	Two 25-ton converters Three 19-ft electric furnaces tapping 70.4 ton heats	Three 30-ton converters Five 20-ft electric furnaces tapping 83.5 ton heats

TABLE II

Estimated Plant Capital Investment Costs Required to Produce

100,000 Tons of Ingots per Year by Different Processes

Item	Description	Case 1 Acid bessemer process with auxiliary electric furnaces		Case 2 Basic bessemer process with auxiliary electric furnaces		Case 3 Standard stationary basic open hearth-process		Case 4 Basic electric furnace process		Case 5 Acid bessemer-basic open hearth-tilting furnace-duplex process		Case 6 Acid bessemer-basic electric furnace-duplex process	
		$	%	$	%	$	%	$	%	$	%	$	%
1	Buildings	571,300	14.3	687,900	11.6	1,011,500	21.6	674,700	20.4			795,400	17.0
2	Building services	112,900	2.8	143,700	2.4	250,300	5.4	129,400	3.9			163,500	3.5
3	Cranes	488,700	12.2	607,400	10.3	525,500	11.2	363,900	11.0			472,300	10.1
4	Furnaces and auxiliaries	1,723,500	43.4	1,933,100	32.7	1,350,900	28.9	916,800	27.8			2,135,700	45.7
5	Charging and pouring	533,000	13.3	636,600	10.8	935,100	20.0	537,700	16.3			462,300	9.9
6	Scrap and material handling	80,200	2.0	79,300	1.3	58,300	1.2	141,400	4.3			133,700	2.9
7	Mold preparation and stripping	40,100	1.0	40,100	0.7	40,100	0.9	40,100	1.2	omitted		40,100	0.9
8	Electric substation	171,300	4.3	206,300	3.5	160,000	3.4	202,900	6.1			227,800	4.9
9	Miscellaneous	239,700	6.0	617,100	10.4	341,000	7.3	292,800	8.9			239,700	5.0
10	Calcining and slag plants	2,800	0.7	966,200	16.3	2,800	0.1	2,800	0.1			2,800	0.1
11	Total estimated cost	3,963,500	100.0	5,917,700	100.0	4,675,500	100.0	3,302,500	100.0			4,673,300	100.0
12	Cost per ton of ingot capacity	$39.64		$59.18		$46.76		$33.03				$46.73	

TABLE III

Estimated Plant Capital Investment Costs Required to Produce

250,000 Tons of Ingots per Year by Different Processes

Item	Description	Case 1 Acid bessemer process with auxiliary electric furnaces		Case 2 Basic bessemer process with auxiliary electric furnaces		Case 3 Standard stationary basic open hearth-process		Case 4 Basic electric furnace process		Case 5 Acid bessemer-basic open hearth-tilting furnace-duplex process		Case 6 Acid bessemer-basic electric furnace-duplex process	
		$	%	$	%	$	%	$	%	$	%	$	%
1	Buildings	1,132,900	19.1	1,327,000	14.6	2,409,800	25.6	1,019,600	20.5	2,033,900	17.6	1,365,600	19.9
2	Building services	214,600	3.6	261,000	2.9	570,600	6.0	184,800	3.7	436,200	3.8	273,800	4.0
3	Cranes	697,800	11.7	751,000	8.2	798,100	8.5	545,400	10.9	1,176,000	10.2	706,700	10.3
4	Furnaces and auxiliaries	2,354,500	39.6	2,767,700	30.3	2,752,100	29.2	1,217,800	24.4	4,870,400	42.1	2,712,600	39.6
5	Charging and pouring	727,200	12.2	916,800	10.1	1,731,500	18.4	1,000,700	20.1	1,932,700	16.7	843,900	12.3
6	Scrap and material handling	142,900	2.4	137,300	1.5	69,900	0.7	194,900	3.9	62,300	0.5	151,900	2.2
7	Mold preparation and stripping	59,400	1.0	59,400	0.6	59,400	0.6	59,400	1.2	59,400	0.5	59,400	0.9
8	Electric substation	240,400	4.0	261,000	2.9	177,600	1.9	251,600	5.1	198,200	1.7	282,900	4.2
9	Miscellaneous	278,900	4.8	925,700	10.2	764,400	8.1	412,200	8.3	698,500	6.1	348,900	5.2
10	Calcining and slag plants	95,200	1.6	1,699,000	18.7	95,200	1.0	95,200	1.9	95,200	0.8	95,200	1.4
11	Total estimated cost	5,943,800	100.0	9,105,900	100.0	9,428,600	100.0	4,981,600	100.0	11,562,800	100.0	6,840,900	100.0
12	Cost per ton of ingot capacity	$23.78		$36.42		$37.71		$19.93		$46.25		$27.36	

TABLE IV

Estimated Plant Capital Investment Costs Required to Produce

500,000 Tons of Ingots per Year by Different Processes

Item	Description	Case 1 Acid bessemer process with auxiliary electric furnaces		Case 2 Basic bessemer process with auxiliary electric furnaces		Case 3 Standard stationary basic open hearth-process		Case 4 Basic electric furnace process		Case 5 Acid bessemer-basic open hearth-tilting furnace-duplex process		Case 6 Acid bessemer electric furnace-duplex process	
		$	%	$	%	$	%	$	%	$	%	$	%
1	Buildings	1,481,300	17.7	1,753,500	14.1	4,135,900	27.0	2,647,100	26.5	3,332,300	19.5	2,190,900	19.2
2	Building services	267,200	3.2	333,700	2.7	946,300	6.2	472,200	4.7	675,100	4.0	437,800	3.8
3	Cranes	874,700	10.5	929,600	7.4	1,163,500	7.6	1,027,900	10.3	1,728,300	10.1	1,398,600	12.3
4	Furnaces and auxiliaries	3,284,400	39.2	3,637,700	29.2	3,917,200	25.6	2,453,700	24.5	6,546,600	38.4	4,298,500	37.7
5	Charging and pouring	918,700	11.0	1,256,400	10.1	2,845,800	18.6	1,378,100	13.8	2,790,500	16.4	1,290,500	11.3
6	Scrap and material handling	177,900	2.1	165,100	1.3	115,600	0.8	370,000	3.7	104,900	0.6	260,700	2.3
7	Mold preparation and stripping	544,700	6.5	544,700	4.4	544,700	3.6	544,700	5.4	544,700	3.2	544,700	4.8
8	Electric substation	284,800	3.4	325,700	2.6	196,500	1.3	341,400	3.4	233,500	1.4	335,200	2.9
9	Miscellaneous	407,900	4.9	1,372,700	11.0	1,297,400	8.5	639,900	6.4	963,300	5.7	523,600	4.6
10	Calcining and slag plants	127,700	1.5	2,146,700	17.2	127,700	0.8	127,700	1.3	127,700	0.7	127,700	1.1
11	Total estimated cost	8,369,300	100.0	12,465,800	100.0	15,290,600	100.0	10,002,700	100.0	17,046,900	100.0	11,408,200	100.0
12	Cost per ton of ingot capacity	$16.74		$24.93		$30.58		$20.01		$34.09		$22.82	

TABLE V

Estimated Plant Capital Investment Costs Required to Produce

1,000,000 Tons of Ingots per Year by Different Processes

Item	Description	Case 1 Acid bessemer process with auxiliary electric furnaces		Case 2 Basic bessemer process with auxiliary electric furnaces		Case 3 Standard stationary basic open hearth-process		Case 4 Basic electric furnace process		Case 5 Acid bessemer-basic open hearth-tilting furnace-duplex process		Case 6 Acid bessemer-basic electric furnace-duplex process	
		$	%	$	%	$	%	$	%	$	%	$	%
1	Buildings			2,767,500	14.0	7,480,200	26.7	4,624,600	26.2	6,484,300	20.8	3,731,800	20.2
2	Building services			516,600	2.6	1,624,400	5.8	794,200	4.5	1,427,300	4.6	732,400	4.0
3	Cranes			1,331,600	6.7	2,492,700	8.9	1,841,400	10.4	2,985,400	9.6	2,004,200	10.8
4	Furnaces and auxiliaries			6,403,200	32.3	7,748,400	27.7	4,814,900	27.3	11,390,000	36.5	7,101,300	38.4
5	Charging and pouring			2,053,200	10.4	4,886,600	17.4	2,283,200	13.0	5,279,300	16.9	2,116,600	11.4
6	Scrap and material handling	omitted		282,600	1.4	158,800	0.6	563,300	3.2	158,800	0.5	433,100	2.4
7	Mold preparation and stripping			986,200	5.0	986,200	3.5	986,200	5.6	986,200	3.2	986,200	5.3
8	Electric substation			499,400	2.5	299,200	1.1	477,800	2.7	367,400	1.2	428,300	2.3
9	Miscellaneous			1,946,300	9.8	2,084,700	7.4	981,400	5.6	1,821,000	5.9	707,700	3.8
10	Calcining and slag plants			3,025,000	15.3	258,500	0.9	258,500	1.5	258,500	0.8	258,500	1.4
11	Total estimated cost			19,811,600	100.0	28,019,700	100.0	17,625,500	100.0	31,158,200	100.0	18,500,100	100.0
12	Cost per ton of ingot capacity			$19.81		$28.02		$17.63		$31.16		$18.50	

TABLE VI

Item	Case 1 — Acid Bessemer Plants	Case 2 — Basic Bessemer Plants	Case 3 — Basic Open Hearth Plants
1.	Buildings Mixer, converter and pouring bays, bottom and blower houses, mold preparation, scrap yard.	Buildings Mixer, converter and pouring bays, bottom and blower houses, mold preparation, scrap yard.	Buildings Charging and pouring bays, stock yard and mold preparation.
2.	Building Services Sewer, water, gas and air-lines; lighting and power lines; railroad trackage; communications, etc.	Building services Sewer, water, gas, and air-lines; lighting and power lines; railroad trackage; communications, etc.	Building services Sewer, water, gas, oil, and air-lines; lighting and power lines; railroad trackage; communications, etc.
3.	Cranes Mixer, charging, steel pouring, pit service, scrap yard, mold yard, bottom house, etc.	Cranes Mixer, charging, steel pouring, pit service, scrap yard, mold yard, bottom house, etc.	Cranes Charging, steel pouring, pit service, stock yard, mold yard.
4.	Furnaces and auxiliaries Hot metal mixer, converters with blowers, electric scrap melting furnaces, bottom jack car, refractory pan mills, rammers, drying ovens, instrumentation, etc.	Furnaces and auxiliaries Hot metal mixer, converters with blowers, electric scrap melting furnaces, bottom jack car, refractory pan mills, rammers, drying ovens, instrumentation, etc.	Furnaces and auxiliaries Stationary open hearth furnaces with waste heat boilers, draft fans, chimneys, refractory mills, instrumentation, etc.
5.	Charging and pouring equipment Hot metal transfer ladles and car, slag pots and pans, steel ladles and relining pit, ingot molds and cars, scrap charging buckets, etc.	Charging and pouring equipment Hot metal transfer ladles and car, slag pots and pans, steel ladles and relining pit, ingot molds and cars, scrap charging buckets, etc.	Charging and pouring equipment Hot metal mixer type and transfer ladles, slag pots, steel ladles and relining pit, ingot molds and cars, charging machines, boxes and buggies, material pans, etc.
6.	Scrap and material handling equipment Magnets, scales, transfer cars, dolomite machine, material bins, pans and buckets, lift trucks, oxy-acetylene equipment, etc.	Scrap and material handling equipment Magnets, scales, car-pullers, transfer cars, dolomite machine, material bins, pans and buckets, lift trucks, oxy-acetylene equipment, etc.	Scrap and material handling equipment Magnet, scales, dolomite machine, material bins and pans, lift trucks, oxy-acetylene equipment, etc.
7.	Mold preparation and stripping Stripper building and utilities, cranes, mold coating system, platforms, etc.	Mold preparation and stripping Stripper building and utilities, cranes, mold coating system, platforms, etc.	Mold preparation and stripping Stripper building and utilities, cranes, mold coating system, platforms, etc.
8.	Electric substation Transformers, high and low voltage switchgear, rectifiers, and control house.	Electric substation Transformers, high and low voltage switchgear, rectifiers, control house, etc.	Electric substation Transformers, high and low voltage switchgear, rectifiers and control house.
9.	Miscellaneous Office and sanitary buildings, switching locomotives, and rolling stock, trucks, air compressor, etc.	Miscellaneous Office and sanitary buildings, switching locomotives, and rolling stock, oxygen plant, trucks, air compressor, etc.	9 Miscellaneous Office and sanitary buildings, highline, switching locomotives and rolling stock, fuel oil facilities, oxygen plant, trucks, air compressor, etc.
10.	Calcining and slag plants Slag dump and slag handling equipment, including crawler crane, oxy-acetylene lances, drop ball, magnets, etc.	Calcining and slag plants Slag dump and slag handling equipment, rotary lime-dolomite kiln with auxiliaries; slag crushing, grinding, bagging and storage facilities, etc.; all buildings.	Calcining and slag plants Slag dump and slag handling equipment, including crawler crane, drop ball, magnets, oxy-acetylene lances, etc.

TABLE VI — Continued

Item	Case 4 — Basic Electric Furnace Plants	Case 5 — Acid Bessemer-Basic Open Hearth-Duplex Plants	Case 6 — Acid Bessemer-Basic Electric Furnace-Duplex Plants
	Description	Description	Description
1.	Buildings Charging and pouring bays, scrap yard and mold preparation.	Buildings Mixer, converter, pouring and charging bays, bottom and blower houses, stock yard and mold preparation.	Buildings Mixer, converter, charging and pouring bays, bottom and blower houses, scrap yard, and mold preparation.
2.	Building services Sewer, water, gas, oil and air-lines; lighting and power lines; railroad trackage; communications, etc.	Building services Sewer, water, gas, oil and air-lines; lighting and power lines; railroad trackage; communications, etc.	Building services Sewer, water, gas and air-lines; lighting and power lines; railroad trackage; communications, etc.
3.	Cranes Charging, steel pouring, pit service, scrap yard, mold yard.	Cranes Mixer, charging, steel pouring, pit service, scrap yard, mold yard, bottom house, etc.	Cranes Mixer, charging, steel pouring, pit service, scrap yard, mold yard, bottom house, etc.
4.	Furnaces and auxiliaries Electric furnaces, transformers, regulators and controls, instruments, refractories, etc.	Furnaces and auxiliaries Hot metal mixer, converters with blowers, bottom jack car, rammers, drying ovens, tilting open hearth furnaces with waste heat boilers, draft fans, chimneys, refractory mills, instrumentation, etc.	Furnaces and auxiliaries Hot metal mixer, converter with blowers, bottom jack car, rammers, drying ovens; electric furnaces, transformers, regulators and controls; instruments, refractories, etc.
5.	Charging and pouring equipment Hot metal mixer type and transfer ladles, slag pots, steel ladles and relining pit, ingot molds and cars, charging machines, boxes, buggies, buckets, material pans, etc.	Charging and pouring equipment Hot and blown metal transfer ladles and cars, slag pots and pans, steel ladles, and relining pit, ingot mold and cars, charging machine, boxes and buggies, material pans, etc.	Charging and pouring equipment Hot metal transfer ladles and cars, slag pots and pans, steel ladles and relining pit, ingot molds and cars, charging machine, boxes, buggies and buckets; material pans, etc.
6.	Scrap and material handling equipment Magnets, scales, transfer cars, dolomite machine, material bins, pans and buckets, lift trucks, oxy-acetylene equipment, etc.	Scrap and material handling equipment Magnets, scales, dolomite machine, material bins and pans, lift trucks, oxy-acetylene equipment, etc.	Scrap and material handling equipment Magnet, scales, transfer cars, dolomite machine, material bins, pans and buckets; lift trucks, oxy-acetylene equipment, etc.
7.	Mold preparation and stripping Stripper building and utilities, cranes, mold coating system, platforms, etc.	Mold preparation and stripping Stripper building and utilities, cranes, mold coating system, platforms, etc.	Mold Preparation and stripping Stripper building and utilities, cranes, mold coating system, platforms, etc.
8.	Electric Substation Transformers, high and low voltage switchgear, rectifiers and control house.	Electric substation Transformers, high and low voltage switchgear, rectifiers, control house, etc.	Electric substation Transformers, high and low voltage switchgear, rectifiers, control house, etc.
9.	Miscellaneous Office and sanitary buildings, switching locomotives and rolling stock, oxygen plant, trucks, air compressor, etc.	Miscellaneous Office and sanitary buildings, highline, switching locomotives and rolling stock, fuel oil facilities, oxygen plant, trucks, air compressor, etc.	Miscellaneous Office and sanitary buildings, switching locomotives and rolling stock, oxygen plant, trucks, air compressor, etc.
10.	Calcining and slag plants Slag dump and slag handling equipment, including crawler crane, oxy-acetylene lances, drop ball, magnets, etc.	Calcining and slag plants Slag dump and slag handling equipment, including crawler crane, oxy-acetylene lances, drop ball, magnets, etc.	Calcining and slag plants Slag dump and slag handling equipment, including crawler crane, oxy-acetylene lances, drop ball, magnets, etc.

figures. This was done to keep the estimates as comparable as possible. On the other hand, more or less standard size units were used for most meltshop auxiliaries such as charging boxes, iron and steel ladles, cinder pots, etc.

DEVELOPMENT OF PLANT LAYOUTS

In the case of the two smaller size plants, the ingots are stripped in an extension of the pouring pit bay by the pit service crane using a portable stripper. Mold preparation is done either in a simple lean-to parallel to the pouring pit, or in a separate building, depending on the size and type of the plant. A separate stripper building with its own stripper crane or cranes was only provided for the larger half million and million-ton plants.

While all the layouts used as a basis for the estimates were made with a view toward the future expansion of the plants, it turned out actually that somewhat less provision for future expansion was provided in the case of the smaller plants than for the larger ones, since any appreciable expansion of the capacity of a small steel plant would be more likely to call for larger size furnaces rather than merely an increase in their number. The two smaller size plants were therefore kept as compact and inexpensive as possible, even though in actual practice, it might be better to provide them with somewhat bigger buildings and more space between units with a view to the installation of larger furnaces in the future.

In this matter of future expansion, large basic open hearth and electric furnace plants have an advantage over bessemer and duplex plants in that their capacity can be increased merely by adding more units to the initial line of furnaces. Expansion is more difficult in the case of the bessemer and duplex shops, due partly to the necessity of providing separate scrap melting facilities, and partly to the fact that in their layouts provision must be made not only for handling and pouring bessemer steel, but also for charging scrap to the converters, blown metal to the duplexing furnaces, and scrap again to the auxiliary scrap melting units. Purely from the point of view of future expansion, it would therefore probably be best to place the bessemer plant auxiliary meltshops in an entirely separate building. However, for this study we have put them all under the same roof; the mixer, converters, scrap melting units and pouring facilities are all together. This results in a lower initial plant cost.

A flat plant site of ample size was assumed in all cases, and standard gage railroad trackage was therefore used throughout in the estimates.

COST BASIS OF THE ESTIMATES

All the costs given in the tables are based on U.S.A. prices as of the summer of 1952, F.A.S. nearest port, for the complete meltshop facilities indicated, erected and ready to operate, including suitable allowances for contingencies, engineering and overhead during construction. No allowance is made for working capital. Under Latin American conditions the total costs shown would be increased by the cost of ocean freight and handling charges from North American ports. In the case of the basic bessemer plants, European prices were used in part for some of the auxiliary equipment. These, however, were correlated with current U.S.A. prices as far as possible.

Building costs were developed on a cost per square foot basis; they are for structural steel, mill type buildings in all cases. The cost of building services is shown separately to emphasize the fact that this is an important item of cost. The cost of cranes, furnace units, and other auxiliary facilities are based on figures from various U. S. suppliers.

Steam driven turbo-blowers for the bessemers were assumed throughout, using increasingly higher steam temperature and pressure conditions for each next larger size plant. This was done on the supposition that, as the size and total capital investment in a project increases, the higher priced supervisory personnel required to operate the more complicated, higher temperature and pressure units can be readily justified by the saving in fuel cost.

A final important point before going on to the tabulated figures, is that the estimates, while based on present day U.S.A. prices, assume normal business conditions under which the plants could be built without any costly delays in the delivery of equipment, and without having to pay premium prices for labor. During the past few years this has distinctly not been the case in the U.S.A. — which will explain why in certain cases our estimates may appear somewhat low to U. S. iron and steel men. By picking and choosing among the known capital cost figures of actual steel plants built since the war, it would probably be possible to find instances where plants approximating our hypothetical capacities, and employing one or another of the six processes studied, had been built for considerably more or less than the figures given in the estimates presented herein. This however does not necessarily detract from their value for comparative purposes.

THE ESTIMATES

The estimates of comparative investment cost finally arrived at for each one of our twenty-two hypothetical steel plant meltshops are given in a series of four tables. (Tables II, III, IV and V.) Each table gives figures for the six different assumed processes. The estimates are further divided into a series of major sub-items, the main ones covering buildings, building services, cranes, furnaces and auxiliaries, charging and pouring equipment, and scrap and material handling equipment. Additional items are shown for the cost of mold preparation and stripping facilities, electric sub-station, calcining and slag plants and "miscellaneous." The cost of calcining and slag plant facilities are of importance only for the basic bessemer process. Material included in sub-items are listed in Table VI.

The total plant cost figures for all plants are summarized in Table VII. The last table (Table VIII) shows the daily amount of molten pig iron or "hot metal" which each plant would require to produce its annual ingot tonnage.

Table VIII warrants some discussion, as it brings out a factor in the overall cost of an integrated steel works that is frequently overlooked, and which is not reflected

TABLE VII

Estimated Plant Capital Investment Costs in Total Dollars and Dollars per Ton of Annual Ingot Capacity

Case No.	Steelmaking process	Assumed total annual plant capacities (Metric tons ingots per year)							
		100,000 Tons		250,000 Tons		500,000 Tons		1,000,000 Tons	
		$	$/Ton	$	$/Ton	$	$/Ton	$	$/Ton
1	Acid bessemer (With auxiliary electric scrap melting furnaces)	3,963,500	39.64	5,943,800	23.78	8,369,300	16.74	omitted	
2	Basic bessemer (Also with auxiliary electric furnaces)	5,917,700	59.18	9,105,900	36.42	12,465,800	24.93	19,811,600	19.81
3	Basic open hearth (Using stationary furnaces)	4,675,500	46.76	9,428,600	37.71	15,290,600	30.58	28,019,700	28.02
4	Basic electric furnace (Using top charge furnaces)	3,302,500	33.03	4,981,600	19.93	10,002,700	20.01	17,625,500	17.63
5	Duplex-acid bessemer-basic open hearth (Using tilting open hearths)	omitted		11,562,800	46.25	17,046,900	34.09	31,158,200	31.16
6	Duplex-acid bessemer-basic electric furnaces (Using top charge electric furnaces)	4,673,300	46.73	6,840,900	27.36	11,408,200	22.82	18,500,100	18.50

in our estimates; i.e., the effect of the steelmaking process employed on the amount of blast furnace and coke oven capacity that must be provided for a given ingot output.

Table VIII indicates that the duplex processes, due to the inherently higher metallic losses associated with the double handling of molten metal which they require, consume more pig iron for a given ingot production than any other process. The acid and basic bessemer processes come next, with the basic open hearth and basic electric furnace processes showing the lowest hot metal requirement. Of the latter two, the electric furnace requires the least. This is due to the fact that, in ordinary basic electric furnace practice, oxidation is supplied only by the iron oxide charged to the furnaces in the form of iron ore, while in the open hearth, part of the oxidation work is done by the flame. In the case of the acid and basic bessemers, oxidation comes entirely from the bessemer air blast.

If we assume that blast furnace and coke plant capacity would cost on the average in the neighborhood of $75 per ton of annual pig iron output, it is obvious that the overall cost of an integrated steel works can be appreciably affected by the choice of steelmaking process, since more pig iron capacity must be provided in some cases than in others. This fact, however, is not taken into account in any way in our meltshop estimates, although the very considerable magnitude of the added investment cost involved can be approximated from the fact that a 100 ton difference in daily pig iron requirement is equivalent to nearly $3,000,000 in terms of blast furnace and coke plant capacity.

DISCUSSION OF THE CAPITAL COST FIGURES

While the detailed explanation of the various cost differences shown by the estimates might be of interest, it is doubtful whether the accuracy of the figures warrants such treatment. Too much significance should not be attributed to differences in the figures one way

TABLE VIII

Daily Pig Iron Requirements for the Production of Steel by Different Processes

Case No.	Process	100,000-Ton plant	250,000-Ton plant	500,000-Ton plant	1,000,000-Ton plant
1	Acid bessemer (With auxiliary electric scrap melting furnaces)	221	545	1070	omitted
2	Basic bessemer (Also with auxiliary electric furnaces)	223	550	1080	2150
3	Basic open hearth (Using stationary furnaces)	200	500	1000	2000
4	Basic electric furnace (Top charge)	189	473	945	1890
5	Duplex-acid bessemer-basic open hearth (Using tilting open hearths)	omitted	580	1160	2320
6	Duplex-acid bessemer-basic electric furnaces (Top charge)	227	568	1135	2270

or another of a few per cent or a few dollars per ton of ingot capacity. This is because of the many assumptions and approximations that had to be made in setting up the basic data used to develop the figures. Comments on the estimates will therefore be limited largely to a short discussion of the figures as summarized in Table VII, which gives the total capital investment cost in each case as well as the cost per ton of ingot capacity.

In the case of the two bessemer processes, the primary fact that stands out from the figures is that, in all three cases for which a comparison can be made, the basic bessemer plants cost approximately 50 per cent more than acid bessemer shops of the same capacity. This is readily explained from the greater number of units resulting from the longer blowing time and shorter lining life of basic as compared to acid converters, plus the extra cost of the auxiliary oxygen calcining and slag plants included in the basic bessemer figures. Even in the case of the basic bessemer, however, the cost per unit of capacity drops off sharply as plant size and output increase. In the smallest group, the basic bessemer shop is the most expensive of all, but in the case of the larger shops, with their bigger units and proportionately lower auxiliary equipment costs, a smaller investment cost results than for either the straight or duplex basic open hearth processes (Cases 3 and 5). The estimates show that the cost per ton of capacity decreases almost equally sharply in both bessemer cases (1 and 2), the unit cost per ton of annual capacity of the million ton basic bessemer plant for instance being only about one-third that of the 100,000-ton one.

Although both the basic open hearth and basic electric furnace plants (Cases 3 and 4) show a similar definite downward trend in unit cost with increase in plant size, it is much less striking than for the two bessemer cases. The unit investment cost of the million-ton basic open hearth plant drops less than 50 per cent from the figure for the smallest size, and the same is true, percentagewise, in the case of the basic electric furnace figures. As might be expected, the drop in unit cost in the case of the two duplex plants (Cases 5 and 6) lies between the bessemer figures and those for the open hearth and electric furnace.

In the three plant size categories for which figures are shown, the acid bessemer-basic open hearth duplex process shows the highest cost per unit of capacity, although in the case of the two larger size plants, the differential between it and the straight basic open hearth narrows considerably, differing only by about $3.50 per annual ton. This means that for large plants the two processes can be taken as more or less identical in investment cost. In other words, when it comes to a choice between the straight vs the duplex open hearth process for a million-ton plant, the question of relative capital cost does not enter into the picture. The composition of the iron ore and the pig iron made from it, plus the steel products to be rolled, will decide which one of these two processes should be used.

In recent years it has frequently been said (we have said so ourselves) that a basic electric furnace plant costs only about half as much as a basic open hearth plant of the same capacity. The figures presented in this paper bear this out only in the case of the 250,000-ton per year plants. For the other plant sizes the ratios are much lower — only 1.42, 1.53, and 1.59. Just why this should be so is not apparent from our detailed figures but it is probably due, in part at least, to the high hot metal charge practice we assumed under Latin American conditions. To be on the safe side, the number of electric furnace units required, as already brought out in the metallurgical discussion, was based on an output of only 4½ heats per furnace per day with 60 per cent hot metal in the total charge. In actual fact, however, American electric furnace plants are currently tapping 40 to 50-ton heats of plain carbon steel at an average rate of six heats per day from all cold scrap charges. It is therefore felt that possibly one reason for the reliatively lower ratio between the capital cost of the basic open hearth and basic electric furnace plants shown by the present estimates is this assumption that each electric furnace would be able to produce only 4½ heats per day from a 60 per cent hot metal charge.

The million-ton per day basic open hearth estimate of over $28,000,000 is appreciably lower than the cost of some of the more recent large new open hearth shops built in the U.S.A. This is perhaps mainly due to the fact that the newer North American open hearth furnaces are designed to tap somewhat larger heats than the 215-ton unlts we have chosen, and consequently would require heavier buildings and cranes than we have felt would be suitable for Latin American conditions. In addition, as stated earlier, our estimating figures were based on the existence of more normal general business conditions, particularly as regards equipment delivery and prices, as well as the availability of construction labor, than has been the case recently in the U.S.A.

Among the smaller size plants, the basic electric furnace shops show the lowest cost per ton of capacity, but when the output gets up to half a million tons, the acid bessemer figures are even lower, and had a figure been developed for a million ton acid bessemer plant, this would still undoubtedly have held true. This result of course is mainly due to the combined effect of larger converters and increased bessemer plant operating time. The same downward trend in cost per unit of capacity is shown, as mentioned before, by the basic bessemer plants; in the million-ton group the basic bessemer cost is down to about the same order of magnitude as the electric furnace and the acid bessemer — basic electric duplex plants; all three are in a narrow range of from $17 to $20 per annual ton.

Also to be noted is the importance, both relatively as well as in absolute figures, of the cost of buildings and building services. Percentagewise, this item of cost varies from a low of 14 per cent in the case of the smallest basic bessemer plant, to a high of 33.2 per cent in the case of the half million ton open hearth shop, and 32.5 per cent in the case of the million-ton open hearth shop. In absolute values, the variation is even greater, ranging from a two-fold difference, from minimum to maximum, for the 100,000-ton plants to nearly three-fold in the case of the million-ton meltshops.

In studying these building figures it should be remembered that they are for the main steel plant buildings and building services only; the office and stripper buildings are separate, as are also all buildings connected with the calcining kilns and slag plant in the case of the basic bessemer.

AMERICAN RECOMMENDED PRACTICE FOR INDUSTRIAL LIGHTING A-11

By J. J. BOOTH
Chairman
AISE Steel Mill Lighting Committee

. . . . Mr. Booth's work with the Illuminating Engineering Society and the American Standards Association represents one item on the standardization program of the Association of Iron and Steel Engineers . . . .

▲ THE Association of Iron and Steel Engineers has been cooperating with the Illuminating Engineering Society in their efforts to revise the "American Recommended Practice of Industrial Lighting," which had been previously issued as American Standards Association Standard A-11 — 1942. The work of the AISE was in general limited to developing the sections which include or were pertinent to lighting practice in integrated steel and iron producing plants.

Adequate lighting is of importance first because it is an essential factor for safe working conditions, and second it is necessary to insure proper workmanship. Many factors are associated with poor illumination. Some of these are direct glare, reflected glare, shadows which hamper seeing and cause after images and visual fatigue.

To insure proper lighting it is necessary to analyze the factors which contribute to seeing, namely the task, environment and the lighting. Visibility of a task or object is determined by size, brightness, contrast and time of viewing. The human eye is affected by age, sub-normal vision, and state of adaption. Sub-normal eyes benefit much more in percentage gain than normal eyes with improvements in illumination. All of these factors are sufficiently dependent on the others so that a deficiency in one may be compensated in a certain degree by augmenting one or the other.

Lighting installations should be designed by a competent illuminating engineer, and the factors which must be considered are quantity of illumination and quality. The desirable quantity of the lighting depends on the work which has to be done, the accuracy required, the fineness of detail, color and reflectivity of work as well as the immediate surroundings. The quantity of illumination which the proposed standard recommends is outlined in Tables I and II.

Table I gives the footcandles required on the general basis. Table II in the Recommended Standard covers all types of industrial lighting. Some of the pertinent items from this table which are of interest to the steel industry are included in Table II.

Glare is one of the harmful factors in lighting and glare is classified as direct when the condition is caused by the lighting source. The lighting practice states that direct glare may be reduced by:

1. Decreasing brightness of light source.
2. Reducing area of high brightness.
3. Increasing angle between glare source and line of vision.
4. Increasing brightness of area surrounding glare source and against which it is seen.

The recommended practice directs the various means by which these can be done.

The practice also develops data giving recommended brightness and brightness ratios. Also the ability to see detail depends upon the brightness difference between the detail and its background, but eyes function most comfortably and efficiently when the brightness within the remainder of the environment are relatively uniform. Detailed conclusions on brightness recommendations are presented in the report. The report also gives recommended reflection factors which vary from 80 per cent for the ceiling to not less than 15 per cent for floors. Recommended practice is also given for daylighting of industrial buildings. However, artificial lighting is usually necessary for most industrial areas, and recommended layouts for direct lighting, semi-direct lighting and diffuse lighting are covered in the practice. This information is further broken down between low-bay and high-bay plant units. The practice also gives an elaborate table which classifies various types of visual tasks and gives a recommended lighting technique to best handle this visual task, for both flat surface and three dimensional objects.

One factor which is not always given the importance which it should is proper maintenance of lighting equip-

TABLE I
General Recommended Values of Illumination

	Current Recommended Practice Footcandles in Service (On task or 30 in. above floor)
Most difficult seeing tasks	
Finest precision work	200-1000*
Involving: Finest detail, Poor contrasts, Long periods of time	
Such as: Extra-fine assembly; precision grinding; extra-fine finishing	
Very difficult seeing tasks	
Precision work	100
Involving: Fine detail, Fair contrasts, Long periods of time	
Such as: Fine assembly; high-speed work; fine finishing	
Difficult and critical seeing tasks	
Prolonged work	50
Involving: Fine detail, Moderate contrasts, Long periods of time	
Such as: Ordinary bench work and assembly; machine shop work; finishing of medium-to-fine parts; office work	
Ordinary seeing tasks	
Involving: Moderately fine detail, Normal contrasts, Intermittent periods of time	30
Such as: Automatic machine operation; rough grinding; garage work areas; switchboards; continuous processes; conference and file rooms; packing and shipping	
Casual seeing tasks	
Such as: Stairways; reception rooms, washrooms and other service areas; active storage	10
Rough seeing tasks	
Such as: Hallways; corridors; passageways; inactive storage	5

*Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the general brightness ratios (recommended in standard) and to avoid glare conditions when light colored materials are involved.

ment. Not only do light units give less actual light as time goes on, but the effect of dirt on the lighting units and the effect of dirt and dust on such items as windows gives a marked reduction in the light available and increases appreciably the task of the eye in seeing properly. For example, dirt on windows can absorb as much as 50 per cent of the light which would ordinarily be transmitted to the area. It is the feeling of the writer that the work which has been accomplished by the Illuminating Engineering Society in sponsoring this ASA Recommended Lighting Practice A-11 is extremely worthwhile and valuable. He therefore, as the representative of the Association of Iron and Steel Engineers on ASA Committee A-11, voted for the adoption of this practice. This practice is now available to industry for use. It was approved on August 22, 1952 by the American Standards Association as American Standard Practice for Industrial Lighting, A 11.1-1952.

Some of the most important points brought out in the reprint "Lighting for Steel Mills, Part 1: Open Hearth" will be quoted in the following report. This report was published in the March 1952 issue of Illuminating Engineering. It was prepared by the Sub-Committee on Lighting in Steel Mills of the Committee on Lighting Study Projects in Industry. This committee consisted of the following:

A. Paulus, Chairman

C. M. Crysler	Lucian Kight
C. J. Enlind	H. J. Mazur
H. Hargest	Carl Ostrom

J. J. Booth represented the Association of Iron and Steel Engineers on this committee. This report formed

TABLE II

Specific Recommended Values of Illumination

	Current Recommended Practice Footcandles in Service (On task or 30 in. above floor)
Coal tipples and cleaning plants:	
Breaking, screening and cleaning	10
Picking	300*
Forge shops and welding	10
Foundries:	
Annealing (furnaces)	10
Cleaning	20
Core making (fine)	50
Core making (medium)	25
Grinding and chipping	30**
Inspection (fine)	100
Inspection (medium fine)	50
Inspection (medium)	30
Molding (medium)	50
Molding (large)	30
Pouring	10
Sorting	10
Storage	10
Shipping and receiving	30
Cupola	10
Shakeout	10
Iron and steel manufacturing (From IES report "Lighting for Steel Mills—Part I—Open Hearth"):	
Open hearth —	
Stock yard	5
Charging floor	10
Pouring side —	
Slag pits	20
Control platforms	20
Mold yard	5
Hot top	20
Hot top storage	10
Checker cellar	5**
Buggy and door repair	20
Stripping yard	10
Scrap stockyard	10
Mixer building	20
Calcining building	10
Skull cracker	5
Cinder dump	5

*Obtained with a combination of general lighting plus specialized supplementary lighting. Care should be taken to keep within the general brightness ratios indicated in standard.

**These seeing tasks generally involve the discrimination of fine detail for long periods of time and under conditions of poor contrast. To provide the required illumination, a combination of the general lighting indicated plus specialized supplementary lighting is necessary. The design and installation of the combination system must not only provide a sufficient amount of light, but also the proper direction of light, diffusion and eye protection. As far as possible it should eliminate direct and reflected glare as well as objectionable shadows.

the basis of the steel plant sections for American standard practice. The following paragraphs are quoted directly from this report:

Since the manufacture of steel is an integrated process, the logical procedure in developing lighting recommendations is to start with the raw materials and follow them through the various processes to the finished products; the principal processes being blast furnaces, from which pig iron is transferred to either bessemer converters, or open hearth or electric furnaces. The material is then subjected to various rolling operations.

Each of these processes can be considered as a separate operation. They may be located anywhere from a few hundred yards to many miles apart. The committee, on the advice of the steel manufacturers, plans to take what it considers the most important operations first, and when all are completed to arrange them in their logical sequence.

Steel manufacture, like many other operations, is undergoing transformation to make it as automatic as possible. The industry plans eventually to scrap the older methods because of higher costs, and therefore the committee is devoting its attention primarily to the newer mills.

Each operation covers a very large area with an extremely low occupancy. For this reason a large part of the area needs a relatively low level of illumination, in some cases just enough for safety. The seeing conditions generally are not critical. The objects viewed are very large and in many instances the brightness is so high that it would be impossible for artificial illumination to compete.

There are a few limited areas that do require critical seeing, such as final inspections, machine shops, etc.; these will be dealt with as separate reports in the future.

The general aim of the committee is to proceed from the open hearth area to rolling operations. When this is completed there will be a return to study blast furnaces and other types of operations.

TABLE III

Analysis of Seeing Tasks and Illumination Recommendations

The following table indicates the area, type of operation, conditions involved and maintained footcandles for open hearth operations.

Area and Operation	Conditions	Maintained footcandles	How obtained
Stock yard Loading scrap metal, ore and limestone into charging boxes by overhead cranes. Stocking of these materials, also by overhead cranes.	Usually clear open space 35-50 feet high with railroad tracks running through the center. Atmosphere relatively clear except for some fumes and vapor drifting in from the pouring aisle. This area may be indoors or outdoors; in either case the area is provided with a traveling crane.	5	Indoor areas are best lighted by general overhead lighting using narrow or medium distribution for high mounting. Similar equipment should also be mounted on the underside of traveling crane. Outdoor areas are best lighted by general overhead lighting, particularly where overhead framing is available. If this is impracticable, directional lighting units having wide distribution can be mounted on the underside of crane girders.
Charging floor Emptying charging boxes into furnace by machine. Adding alloy materials by shovel or charging box.	Relatively clear open space 35-50 feet high with railroad tracks and tracks for charging machines. Atmosphere relatively clear except for fumes and vapor drifting in from pouring aisle.	10	General overhead lighting provided by medium to concentrated distribution industrial lighting equipment. Supplemental lights should be mounted on underside of crane. Localized lighting should be provided on the instrument panel which controls the furnace operation. Additional lighting should be provided over the small material storage bins. This usually can be best accomplished by mounting directional lighting equipment on the steel columns or on the underside of the crane girders.
Pouring Tapping open hearth furnace into ladles and emptying ladles into molds.	Concentrated area of high brightness due to molten metal. Clouds of fumes and vapor from ladles at time of tapping and pouring. Rough floor. Ceiling height 40-80 feet.	5 general plus 15 supplementary at slag pits and control platforms.	General overhead lighting using concentrated or medium beam distribution for high mounting. Auxiliary lighting should be provided for the slag pits. Directional lighting equipment can be mounted permanently on the steel columns above the platform level which is part of the charging floor area. If this is not feasible, portable units mounted on a standard having either a tripod or flat platform with casters. This can be set on the platform above the slag pit area. At the ingot pouring platform supplementary lighting is necessary and can be obtained by mounting directional lighting equipment on the columns back of the platform.
Mold yard Where ingot molds are cleaned, coated, sprayed, and stored.	Very dirty, with usually a high concentration of fumes from the spraying operation.	5	General overhead, plus lighting on underside of crane. Consideration should be given to suitable maintenance features such as dirt resistant design, dust-tight covers, etc.
Hot top Relining and repairing the hot top section of molds.	Relatively clear except for fumes and vapor drifting in from adjacent aisles.	20	General overhead lighting of approximately 10 footcandles should be provided. Supplemental lighting at the point of hot top repairs and mold relining should be provided. Directional lighting equipment can be mounted on the overhead beams; for close inspection of the lining it is necessary to use extension cords.

TABLE III — (Continued)

Area and Operation	Conditions	Maintained footcandles	How obtained
Hot top storage Storage and placing hot top on molds.	Atmosphere relatively clear, requires good seeing in order to place thin steel gasket accurately between hot top and mold.	10	General overhead lighting plus lighting units under crane.
Checker cellar Generally very little work done except for repairs. Brick work.	Fairly low ceiling area. Many supports, pipes and ducts.	5 plus supplementary	Locate overhead lights wherever possible. Provide portable local lights for repair work.
Buggy and door repair Repair shop for charging box, buggies, and furnace doors. Rough machine and bench work, Cutting and welding.	Typical metal fabricating shop conditions. Ceiling height usually about 15 feet.	20	General overhead lighting.
Stripping yard Remove mold from ingot by stripping machine	May be inside high bay building or outside.	10	For inside area general overhead lighting. For outdoor areas directional lighting equipment mounted under crane girders or overhead units mounted on messenger cable.
Scrap stock yard Active storage and cutting of scrap by torch and shears.	Usually outdoors with overhead cranes.	10	Standard industrial lighting equipment can be mounted on messenger cable strung between the crane supporting steel structure with floodlights on towers or poles erected along side of the crane runway.
Mixer building In this area, molten metal from blast furnace is poured into a tilting vessel which acts as a reservoir. The vessel, called a mixer, has a capacity from 300 to 1500 tons.	Vapors and fumes present from the molten metal. Ceiling height is about 60 feet.	20 on pouring elevation.	Due to very large mixers and the bins containing raw material mounted above them, it is almost impossible to provide general illumination over the entire area. Lighting equipment should be located where possible and convenient. The two most important places are at the top of the mixer and at the pouring level. This should take the form of supplemental lighting either from symmetrical or directional lighting equipment.
Calcining building Storage and crushing limestone.	Very dirty. Ceiling height varies from 60-80 feet.	10 on working platform.	General overhead lighting is not advisable due to the height of crushing machinery and bins for feeding same. Industrial lighting units should be provided at convenient locations on all working platforms or levels.
Skull cracker Breaking up solid material which freezes on bottom or sides of ladles and breaking old ingot molds.	Usually outside with overhead crane.	5	General lighting from directional lighting equipment mounted on underside of crane girders. Lighting should also be provided under the cranes.
Cinder dump Storage of cinders from open hearth furnace.	Outside with overhead crane.	5	General lighting from overhead or directional lighting equipment. Lighting units under crane.

INTRODUCTION

(a) The open hearth furnace refines scrap, pig iron, and other important but less bulky materials into a product suitable for rolling operations. The seeing task involves viewing very large objects handled in bulk. The furnaces are in banks and the various crews move from furnace to furnace, thus giving an almost continuous pouring operation.

(b) The seeing task in most of the areas of the open hearth operations is not critical. The charging floor is a very large area normally occupied by very few people. Most of the materials are handled by machinery and the smaller objects viewed will probably be a few small tools such as shovels and small sample ladles. The product itself is viewed through the furnace door and being molten metal has a brightness of a high order. During the times of charging and tapping the furnace and pouring molds from the ladle, the glare or brightness is usually so high that it is impossible to offset this brightness with artificial illumination. Similarly, the pouring floor has practically no workmen except for periodic cleaning. Lighting in this area is primarily that for safety.

(c) The most critical seeing task involves the lining of "hot tops." The material used is black which offers no contrast, and the opening is small and tilted at an angle of approximately 30 degrees above the horizontal, making it very difficult to project light into the interior. A combination of general and local lighting is therefore indicated. Another seeing task of a medium order is the repairing of the open hearth furnace. This involves rather accurate brick laying operations. Since this is done at very infrequent intervals, a portable floodlight is usually used.

(d) In general, the larger portion of the area is occupied by the open hearth operations require very little

critical seeing and low levels of illumination can be used to accomplish this and also to serve as an aid to safety.

SELECTION OF LUMINAIRES

(a)—*Mounting height*—Whether the open hearth is old or new, high bay areas will predominate throughout and most bays will be equipped with overhead cranes. The choice of photometric distribution will be influenced by mounting height and spacing but in general the concentrating or narrow beam type will be selected. Reflection factors of vertical surfaces are not very high when new and eventually will reach a value in the neighborhood of 5 to 10 per cent; consequently, little vertical illumination can be expected from these surfaces and where vertical illumination is definitely required (hot top repair and checker repair) it must be obtained from other than a general lighting system.

(b)—*Maintenance*—Maintenance of lighting equipment is difficult due to high mounting heights and interference with continuous operations. The resultant high depreciation should be considered in designing a lighting system. Depreciation varies with the design of the luminaire; dust-resistant features may reduce the rate appreciably. Maintenance varies widely in different plants from wiping off reflecting surfaces at time of lamp replacement to definite schedule of cleaning every 60 days. In calculating a lighting system a knowledge of maintenance schedules is necessary to determine depreciation factor.

(c)—*Light source*—The type of power available will usually dictate the type of light source that can be used. Twenty-five cycle and direct current predominate in the older type mills. There is a trend towards 60-cycle, particularly for new mills.

Where only 25-cycle and direct current are available, filament lamps are preferable. Where 60-cycle is available it is possible to use high intensity mercury vapor lamps, either alone or in combination with filament lamps. Where mounting height is not excessive, fluorescent lamps can be applied.

Color of lighting is not very important in open hearth operations. High intensity mercury vapor lamps are satisfactory for most areas. Probably the only place where color might be a factor is on the charging floor area and there a combination of mercury and incandescent filament lamps is practicable. Machine shop or buggy and door repair departments lend themselves ideally to the use of fluorescent lighting.

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PROGRAM

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BUFFALO, N. Y.

MAY 18, 19, 1953

MONDAY, MAY 18, 1953

9:00 a.m. — Registration — Mezzanine Floor Corridor

9:30 a.m. — Rolling Mill Session — Chinese Room

Co-Chairmen:
Alex Montgomery, Jr.
Assistant to Vice President, Rolling Mills
United States Steel Corp.
Pittsburgh, Pa.

George A. Henderson
Superintendent of Mills
Bethlehem Steel Co.
Lackawanna, N. Y.

"USE OF OXY-ACETYLENE IN ROLLING MILLS," by R. L. Deily, Steel Mill Representative, Air Reduction Co., New York, N. Y.

"FLYING SHEARS FOR BILLET, BAR AND ROD MILLS," by E. S. Murrah, Electrical Engineer and J. H. Hitchcock, Director of Research, Morgan Construction Co. Worcester, Mass.

9:30 a.m. — Electrical Session — Empire State Room

Co-Chairmen:
W. J. Tunny
Superintendent Electrical Maintenance
Youngstown Sheet & Tube Co.
East Chicago, Ind.

Philip B. Mansfield
Electrical Engineer
Republic Steel Corp.
Buffalo, N. Y.

"ELECTRIC SYSTEMS FOR HOT STRIP MILLS," by R. E. Marrs, Steel Mill Section, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

"ELECTRICAL EQUIPMENT FOR THE JONES & LAUGHLIN BLOOMING MILL," by A. W. Smith, Steel Mill Engineer, Westinghouse Electric Corp., East Pittsburgh, Pa. and George Kaufman, Chief Electrical Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

2:00 p.m. — Rolling Mill Session — Chinese Room

Co-Chairmen:
Louis Moses, Mill Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

James N. Imel, Superintendent
Strip and Sheet Department
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

"A NEW THEORY OF HOT ROLLING," by G. S. Mican, Division Superintendent of Rolling, United States Steel Corp., Chicago, Ill.

"MECHANICAL DESIGN AND OPERATION OF JONES & LAUGHLIN'S NEW BLOOMING MILL," by J. H. Mayer, Assistant Superintendent Blooming Mills, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

"ROLL PASS DESIGN AND THE ROLLING OF AUTOMOTIVE RIM SECTIONS," by Howard H. Morgan, Assistant Roll Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

2:00 p.m. — Combustion Session — Empire State Room

Co-Chairmen:
E. T. W. Bailey, Chief Combustion Engineer
The Steel Co. of Canada, Ltd.
Hamilton, Ontario, Canada

A. F. Kritscher, Development Engineer
National Tube Division
United States Steel Corp.
Pittsburgh, Pa.

"MODERN AUTOMATIC FUEL SHUT-OFF SYSTEM FOR SOAKING PITS WHILE CHARGING OR DRAWING INGOTS," by A. L. Lancaster, Chief of Electrical Design, Amsler Morton Corp., Pittsburgh, Pa.

"SOAKING PIT FUEL SELECTION," by F. R. Pullen, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

"DESIGN AND APPLICATION OF BRONZE SLIPPERS IN UNIVERSAL COUPLINGS," by J. Robert Lottes, Sales Engineer, National Bearing Division, American Brake Shoe Co., Cleveland, Ohio.

7:00 p.m. — Informal Dinner — Ball Room

TUESDAY, MAY 19, 1953

INSPECTION TRIP — Steel Co. of Canada, Hamilton, Ontario, Canada.

9:00 a.m. — Buses leave from Hotel Statler

TEMPERATURE DISTRIBUTION IN CARBON HEARTHS

By R. D. WESTBROOK
Research Laboratory
National Carbon Co.
Cleveland, Ohio

. . . . paper presented at Eastern States Blast Furnace and Coke Oven Association meeting held on February 13, 1953, Pittsburgh, Pa. . . . .

▲ THE advantages of carbon as a lining for blast furnace hearths and sidewalls have been demonstrated conclusively in Europe, England, and in the United States. The satisfactory performance of carbon hearths has been discussed in numerous technical articles and the increases in tonnage production over that obtained with ceramic hearths have been reported.

While carbon has now become an accepted hearth material and serious consideration is being given even to all-carbon blast furnace linings, there have been conflicting opinions as to the best methods of constructing the hearth, the optimum thickness of the carbon lining, and the most effective cooling means to be employed. Since carbon has a higher thermal conductivity than most ceramics, the carbon blast furnace hearth floor will operate at higher temperatures than the ceramic hearth floor unless the hearth is properly designed as to thickness and provided with sufficient cooling. Water-cooling can be used to reduce temperatures at the outer surface of a carbon hearth, but it is not practical beneath the hearth because of the high temperatures as well as the installation and maintenance difficulties involved.

The determination of optimum hearth thicknesses and effective cooling techniques requires a knowledge of the temperature distribution in the carbon hearth itself. The use of laboratory models has permitted the determination of hearth floor temperature distributions under a number of conditions, and has suggested methods which might be employed to reduce hearth temperatures. It is felt that the results obtained can be applied in a general way to determine temperatures encountered in full-scale blast furnace operation, and to provide technical assistance in blast furnace design. But it should be remembered that data obtained on small-scale models should not be considered as exactly reproducing field conditions.

The laboratory models used in the experiments reported here were scaled to the dimensions of a blast furnace hearth of 20-ft inside diameter and 3-ft sidewalls, each model being 15 to 16 in. high, with an outside diameter of 20 in. This is a scale factor of about 15.5:1. Carbon crucibles cut from solid carbon blocks were used to simulate the hearths. The interior of the crucible under test was held at 100 C by filling it with water and maintaining the water at the boiling point by means of an immersion heater. The crucible rested on a 6-in. layer of Benezet hearth and bosh brick, this thickness scaled to represent an 8-ft layer as might be used in the field under a regular 20-ft furnace. A thin layer of graphite paste was used between the carbon crucible and the ceramic base to ensure good thermal

contact. The walls of the crucible were water-cooled down to the ceramic base by a circular spray head using tap water.

Figure 1 is a cross-section view of the carbon hearth and the ceramic base, showing the locations of the iron-constantan thermocouples used to read temperatures. Couples 1 through 6 read temperatures from a point at the bottom of the hearth center along a radius of the bottom surface to the perimeter of the hearth; couples 7 and 8 gave temperatures at the outer surface of the hearth where water-cooling was effective. Couples 9 to 12 and 13-14 gave temperatures inside the body of the hearth and ceramic base, as indicated.

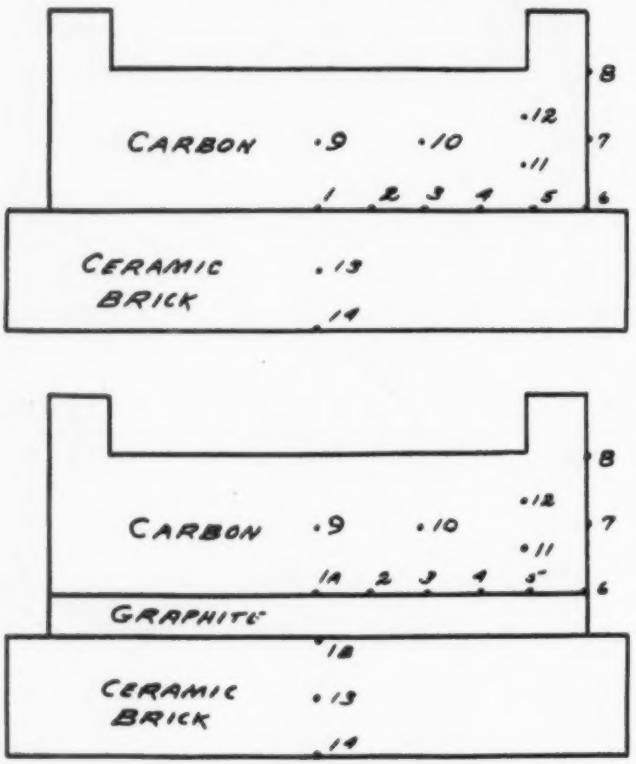

Figure 1 — Model cross-sections show thermocouple locations.

Three models were constructed and tested. Table I shows the type of carbon, hearth diameters, wall and hearth thicknesses, and thermal conductivities of each. The dimensional figures for the full scale furnace configurations are given, with the corresponding model dimensions. Since models two and three gave nearly identical results for temperature distributions despite the different thermal conductivities of the material, only the results obtained with models one and two are considered here. For this reason, the increase of the thermal conductivity of carbon with temperature was omitted from the extrapolations of model temperatures to operational temperatures.

The establishment of thermal gradients through the carbon model by maintaining a constant temperature differential across the inner surfaces and the outer sidewalls, permitted extrapolation by simple proportionality of the measured temperatures in the model to operational furnace temperatures. Near equilibrium temperatures were attained after some 12 to 14 hours heating, and the temperatures were recorded at this time. Since the scale factor for the models is about 15.5:1, the heating rate is $(15.5)^2$ or 240 times as rapid as that encountered in a full-scale blast furnace. Thus a heating period of 12 hours corresponds to about four months in field operation. The recorded temperatures were extrapolated to those which would occur if the interior of the hearth were at 1500 C and (1) the exterior surface temperature at 0 C which is a reasonable approximation under good cooling conditions, or (2) at a 600 C cooling temperature which was chosen as an extremely poor cooling condition.

It should be emphasized that this laboratory setup employed direct contact cooling which cannot be obtained in service but which provided the most satisfactory method of establishing definite temperatures on which the calculations could be based.

In general the ceramic brick reaches its highest temperature at the point underlying the bottom center hearth region. For a carbon hearth floor with a 20-ft inside diameter and 50 in. thick, an interior temperature of 1500 C, and an assumed 0 C external cooling temperature, our measurements indicate that this central carbon-ceramic boundary reaches a temperature of 1250 C. Iron freezes at about 1180 C. Isotherms for this configuration are shown in Figure 2. For a furnace operating under similar conditions, but with a carbon hearth thickness of 76 in., the corresponding central temperature is approximately 950 C. Figure 3 shows isotherms for this condition. If the exterior cooling temperature rises to 600 C, the central hearth temperatures of 1260 C and 950 C are increased to about 1350 C, and 1160 C, respectively. Figures 4 and 5 show the isotherms obtained under these conditions.

An article by E. W. Voice in the *Iron and Steel Engineer*, July, 1952, gives carbon hearth floor temperatures calculated by L. F. Daws for a 25-ft inside diameter

TABLE I

Hearth Models

Carbon material	K-Btu units	Inside diameter		Wall thickness		Hearth thickness		Ceramic brick thickness	
		Furnace, ft	Model, in.	Furnace, ft	Model, in.	Furnace, in.	Model, in.	Furnace, ft	Model, in.
D Grade blast furnace lining stock...	8	20	15.5	3	2.3	50	3.2	7.8	6
D Grade blast furnace lining stock...	8	20	15.5	3	2.3	76	4.9	7.8	6
Petroleum coke stock.....	3	20	15.5	3	2.3	76	4.9	7.8	6

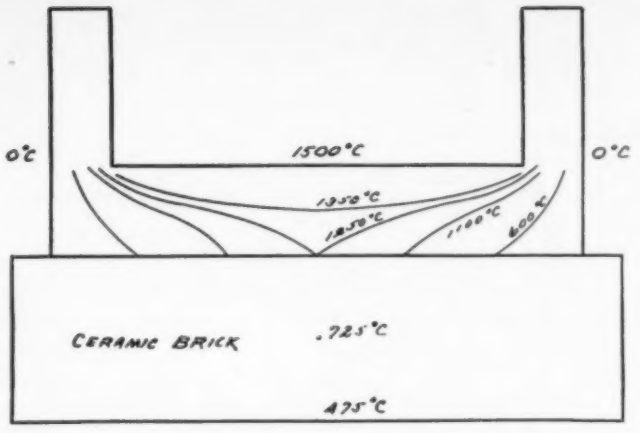

Figure 2 — Isotherms are given for a 50-in. hearth with cooling temperature of 0 C.

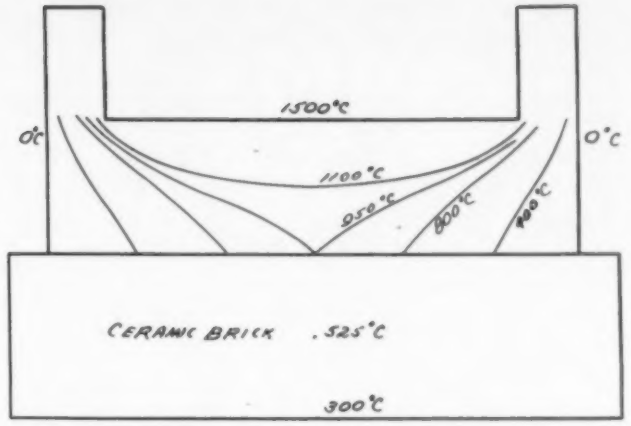

Figure 3 — Isotherms are given for a 76-in. hearth with cooling temperature of 0 C.

furnace, 4½-ft hearth floor and 5-ft wall thicknesses, with 9 ft of refractory brick underlying the hearth. Comparison of Daws' results and the results reported here must be qualitative because of the different relative dimensions involved. He worked with a proportionately thinner carbon hearth floor and obtained higher overall

These data indicate that the temperature of the ceramic brick decreases with increasing carbon thickness, and that to prevent temperatures at the carbon-ceramic interface from reaching the melting point of iron, 1180 C, and thus permitting penetration of the iron into the ceramic base, the carbon hearth floor should have a

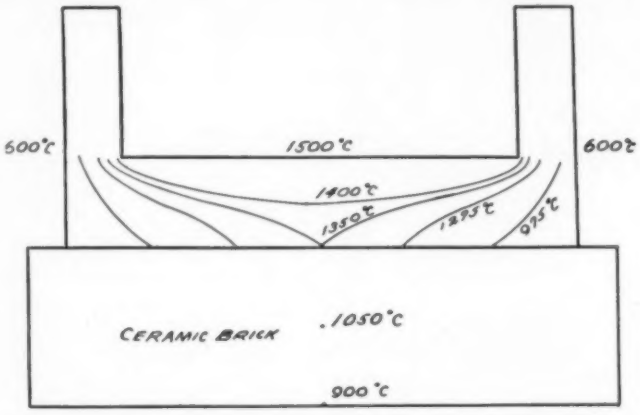

Figure 4 — Isotherms are given for a 50-in. hearth with cooling temperature of 600 C.

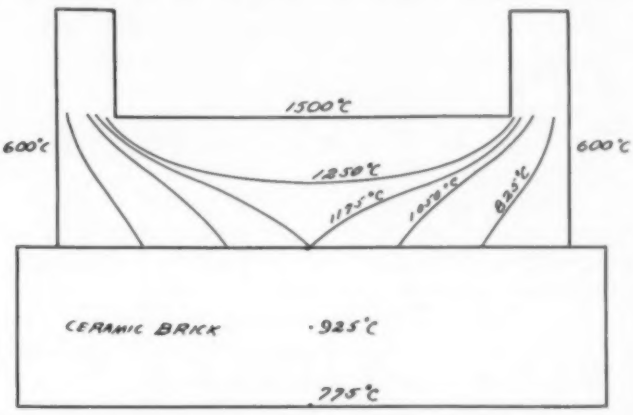

Figure 5 — Isotherms are given for a 76-in. hearth with cooling temperature of 600 C.

hearth temperatures. However, by making first order corrections for these differences, his calculated temperature and our extrapolated temperature at the central interface point agree within 40 C.

thickness at least one-quarter the outside diameter of the furnace.

Obviously, some means of sub-hearth cooling could materially reduce the hearth temperatures. One method

Figure 6 — Isotherms are given for a 50-in. hearth with graphite layer with cooling temperature of 0 C.

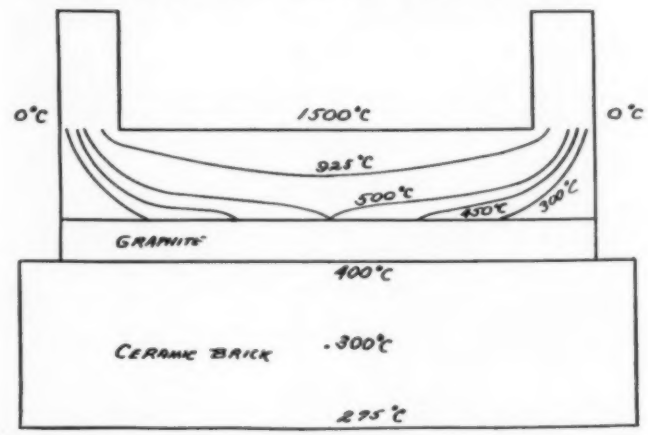

Figure 7 — Isotherms are given for a 50-in. hearth with graphite layer with cooling temperature of 600 C.

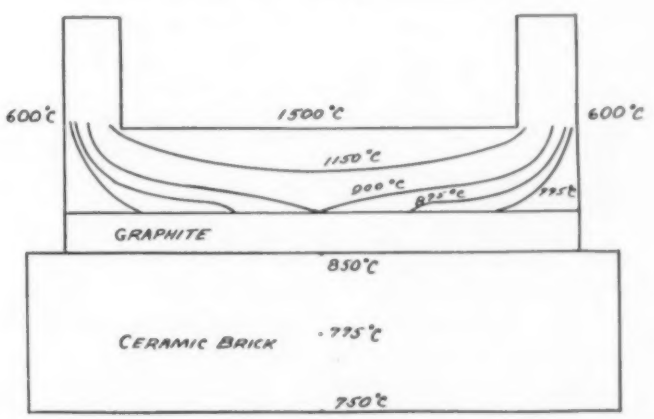

TABLE II

Summary of Bottom Center Hearth Temperatures
20-ft Inside Diameter Furnace and 3-ft Side Walls

Cooling and internal temperatures	76-in. Hearth	50-in. Hearth	50-in. Hearth and 23-in. Graphite	
0 C - 1500 C	950 C	1250 C	500 C	400 C*
600 C - 1500 C	1175 C	1350 C	900 C	850 C*

*These temperatures occur at the central graphite-ceramic brick interface point.

of accomplishing this might be to install a solid layer of graphite between the ceramic brick and the carbon hearth. Since the thermal conductivity of graphite is 10 to 25 times that of carbon, a graphite layer properly installed and provided with adequate water cooling on its outer surface should provide an excellent heat sink beneath the hearth.

To test this idea, a solid graphite disk machined to the same diameter as the carbon model and a thickness equivalent to about 23 in. of graphite under a 20-ft furnace, was laid between the model and the ceramic brick base, and the surfaces covered with graphite paste to ensure good thermal contact. The results indicate a striking temperature reduction of 250-400 C in the inner central hearth region as compared with standard construction using no sub-hearth cooling medium. An even greater reduction of temperature was indicated at the bottom center section of the carbon hearth. The model simulating a carbon hearth thickness of 50 in. and an assumed cooling temperature of 0 C on the outside wall indicated an interface temperature decrease from 1250 to 500 C. Figure 6 shows isotherms obtained with this configuration employing the graphite layer. In the same furnace with an assumed cooling temperature of 600 C, the interface temperature decreases from 1350 to 900 C, as shown in Figure 7.

The efficiency of such a graphite layer is, of course, dependent on the quality of the joints and the amount of cooling. One possible method of installation would be to lay solid lengths of graphite out from the center of the furnace like spokes in a wheel. This would provide an unbroken path for heat flow from the center region of the furnace through to the exterior water cooled surface. It should be pointed out that the use of graphite as a sub-hearth cooling element is theoretically sound provided contact can be developed between the (continuous) graphite and the coolers. Probably this could be accomplished only with rather radical changes in design of the furnace cooling members and the ability of graphite producers to make longer sections.

Table II summarizes all the data obtained on central interface temperatures under the various conditions tested. If these data are representative, the following conclusions may be drawn:

1. Temperature of the ceramic brick decreases with increased carbon hearth thickness.
2. To keep the highest temperature reached by the ceramic brick substantially below the melting point of iron, the carbon hearth thickness should be at least one-quarter the outside diameter of the furnace.
3. The addition of a layer of graphite between the carbon hearth and the ceramic base will markedly decrease the interface temperatures provided the outer surface of the graphite layer is sufficiently cooled and thermal barriers, such as cracks, joints, etc., through the graphite are minimized.
4. When ceramic brick is used as a foundation, carbon hearth temperatures are affected only to a small degree by variations of thermal conductivity between 3 and 8 Btu/hr/sq ft/(°F/ft).

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5. "*The Evolution of the All-Carbon Blast Furnace*," by G. D. Elliott, J. H. Chesters, and J. Mackenzie, Iron and Steel Institute, Journal, 167:273-82 (1951).

6. "*Calculations on Carbon Hearths for Blast Furnaces*," by E. W. Voice, 1952 Proceedings of the AISE, p. 445.

APPENDIX

Conversion of model temperatures to operational temperatures.

The conversion can be done by simple proportionality if the heating and cooling temperatures of the model and the blast furnace are known.

$$\frac{\text{T anywhere in the model} - \text{T cooling water}}{\text{T boiling water} - \text{T cooling water}} = \frac{\text{T anywhere in the hearth} - \text{T cooling surface}}{\text{T molten iron} - \text{T cooling surface}},$$

$$\text{or } \frac{Tm - Tcw}{Tbw - Tcw} = \frac{Thf - Tcs}{Tmi - Tcs}.$$

$$\text{Then } Thf = \frac{(Tm - Tcw)(Tmi - Tcs)}{Tbw - Tcw} + Tcs$$

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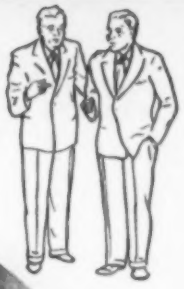

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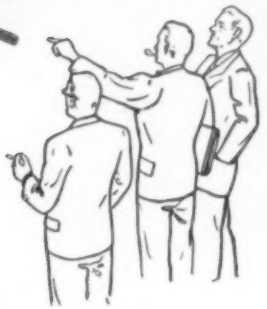

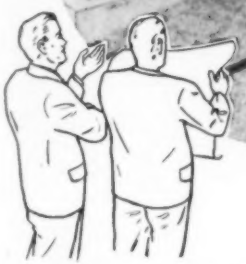

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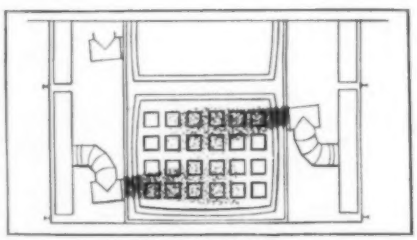
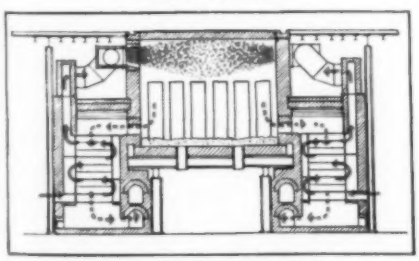


PLAN VIEW



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CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, April 27, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

Inspection Trip — 4:00 P.M. — Connors Steel Co.

"The Casting and Rolling of Billet Size Ingots," by B. Campbell Blake, Vice President-General Manager, Connors Steel Co., Birmingham, Ala.

Thomas Jefferson Hotel, Birmingham, Ala.

▲

BUFFALO SECTION

Tuesday, April 14, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Types of Refractories and Their Applications," by H. A. Robertson, Refractories Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada.

Hotel Sheraton, 715 Delaware Ave., Buffalo, N. Y.

▲

CHICAGO SECTION

Tuesday April 7, 1953 — Dinner 6:15 P.M., Meeting 7:45 P.M.

SYMPOSIUM —

"Air Pollution and Remedies," by Jay J. Seaver, President, J. J. Seaver Engineers, Chicago, Ill.

"The Role of Electrical Precipitation in the Steel Industry," by H. L. Richardson, District Manager, Research Corp., Pittsburgh, Pa.

"The Electric Air Cleaner," by George F. Landgraf, Vice President in Charge of Engineering, and R. W. McGuire, Industrial Sales Manager, Trion, Inc., Pittsburgh, Pa.

"Air Pollution Control in Steel Industry," by G. A. Howell, Assistant to Chief Engineer, Steel Manufacturing, U. S. Steel Corp., Pittsburgh, Pa.

"Dust and Fume Problems in the Steel Industry," by Richard F. O'Mara, General Sales Manager, Western Precipitation Corp., Los Angeles, Calif.

Phil Smidt's Restaurant, 1205 N. Calumet Ave., Hammond, Ind.

CLEVELAND SECTION

Monday, April 20, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M. at Cleveland.

Tuesday, April 21, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M. at Youngstown.

"Carbon for the Steelmaker," by E. F. Sipp, Assistant District Manager, and J. S. Copley, Sales Representative, National Carbon Co., Pittsburgh, Pa.

Cleveland — Coytons Marine Dining Room, 508 W. Superior Ave., Cleveland, Ohio.

Youngstown — El Rio Club, Youngstown-Warren Rd., Route 422, Youngstown, Ohio.

▲

DETROIT SECTION

Tuesday, April 14, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Continuous Pouring of Steel," by Isaac Harter, Supervisor Continuous Casting, Babcock & Wilcox Co., Tube Division, Beaver Falls, Pa.

Horace Rackham Educational Memorial, Detroit, Mich.

▲

PHILADELPHIA SECTION

Saturday, April 4, 1953 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"General Aspects of Fairless Works," by H. S. Spitz, Assistant Chief Engineer, Construction Engineering Bureau, United States Steel Corp., Fairless Works, Morrisville, Pa.

Engineers' Club, 1317 Spruce St., Philadelphia, Pa.

▲

PITTSBURGH SECTION

Monday, April 13, 1953 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"The Manufacture of Heavy Forgings," by L. R. Cooper, Assistant to Works Manager, Heppenstall Co., Pittsburgh, Pa.

University Club, University Place, Pittsburgh, Pa.

200-ton 6-motor 98'-3" Span Crane with two 100-ton Hoists and one auxiliary 10-ton Hoist. In Concentrator Grinding Bay.

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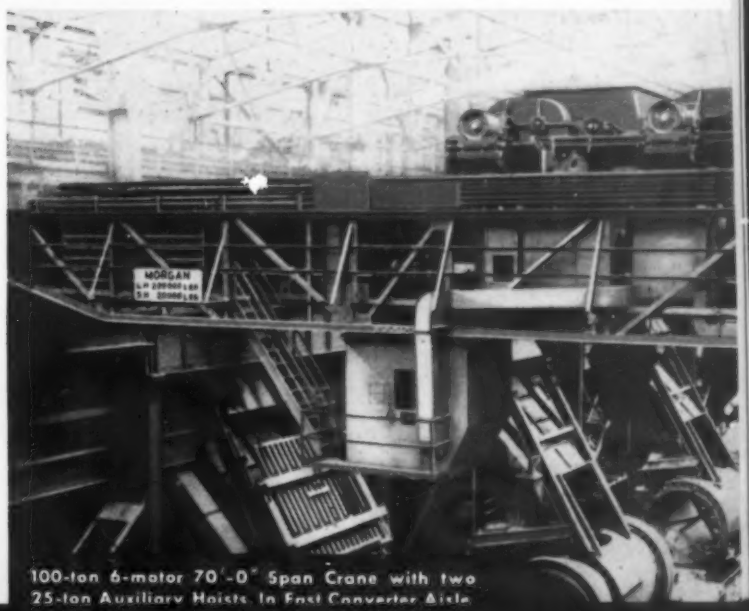

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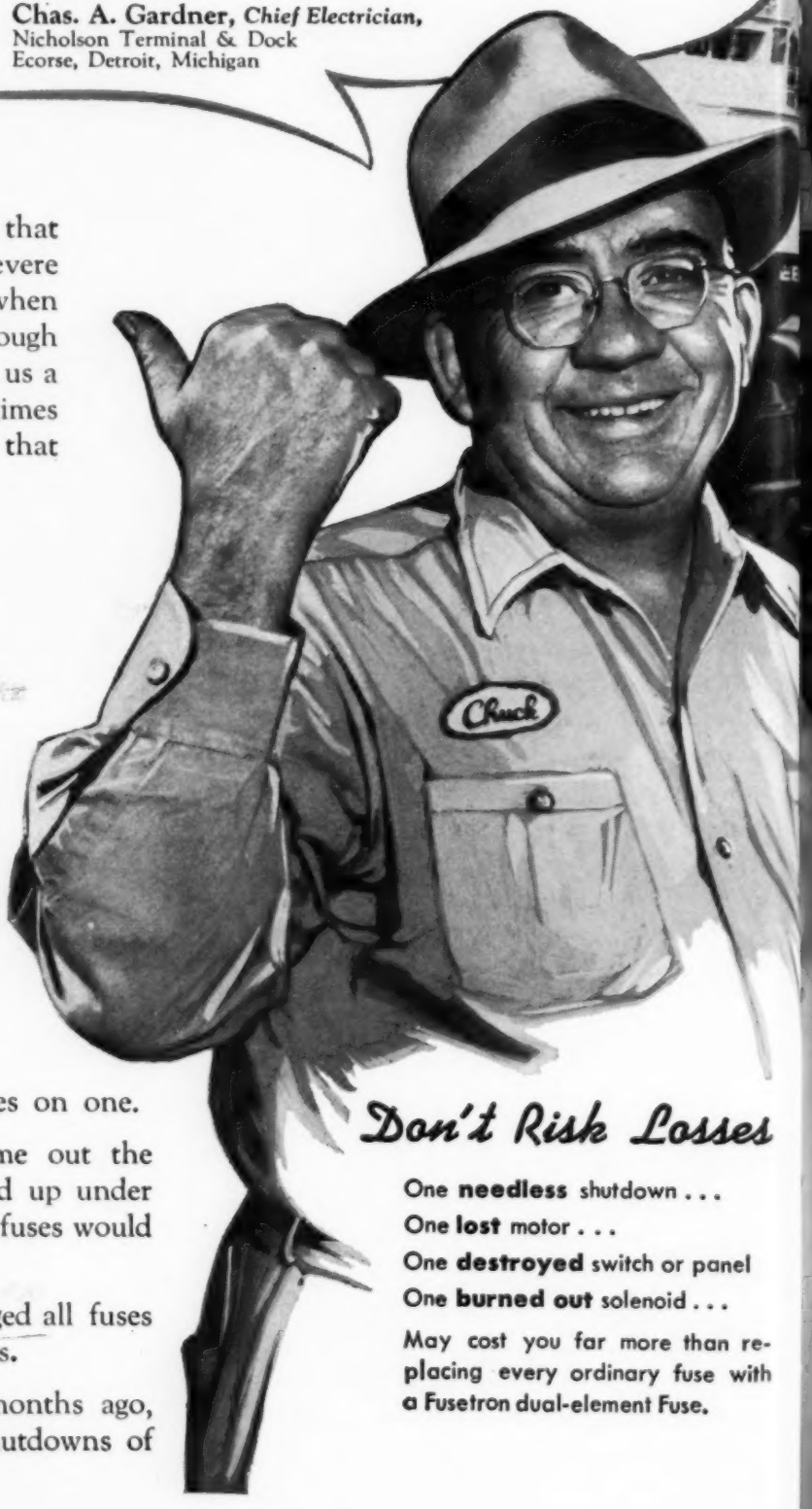

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▲ Methods of manufacturing the world's longest steel forging — 110 feet long and weighing 145 tons — by Bethlehem Steel Co. require much ingenuity. The forging is one of 18 rectangular column sections for a giant 50,000-ton die forging press, being supplied by the Loewy Construction Co. of New York, which will produce airframe components quicker and more economically under the Air Force heavy press program. The press will have six columns, each composed of three of the rectangular forgings.

Figure 1 — Crane has just lifted 275-ton ingot from an ingot mold at Bethlehem plant. Specially rigged railroad car will convey ingot to forge shop.

When assembled at North Grafton, Mass., next year, the press will be equal to a 10-story building in height. It will be the aircraft industry's largest press of its type of design.

Beginning with a round corrugated ingot weighing 275 tons, forging of the column section was completed after a series of five individual heatings and forging operations under a 7500-ton press. Roughly its final shape is that of a 110-ft flat dumbell with a main body width of 44 in. and swelling to a maximum width of 100 in. at the ends. It is 16 in. thick throughout.

Bethlehem attempted to prevent some production difficulties by forging in advance two scale models of one-fifth the column's dimensions. However, it was realized that the problems of handling a 110-ft member within the 80-ft bay of the forge shop could not all be anticipated.

Special handling equipment was made so that two cranes, of 200 and 125-ton capacity, could carry the forging from the heating furnace to the forge when it had elongated to 40 or 50 ft. Due to the plastic condition of the steel at forging temperature of 2300 F, it would then easily bend of its own weight into an awkward shape if not properly supported throughout its length. The handling equipment comprised a unique arrangement of supports at regular intervals to distribute the load equally. This equipment was designed and manufactured at Bethlehem for the handling of these forgings.

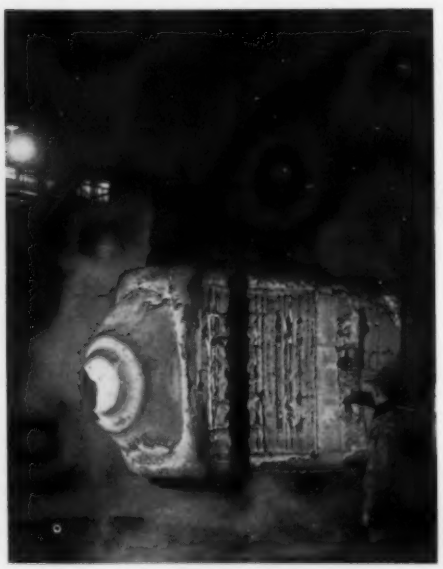


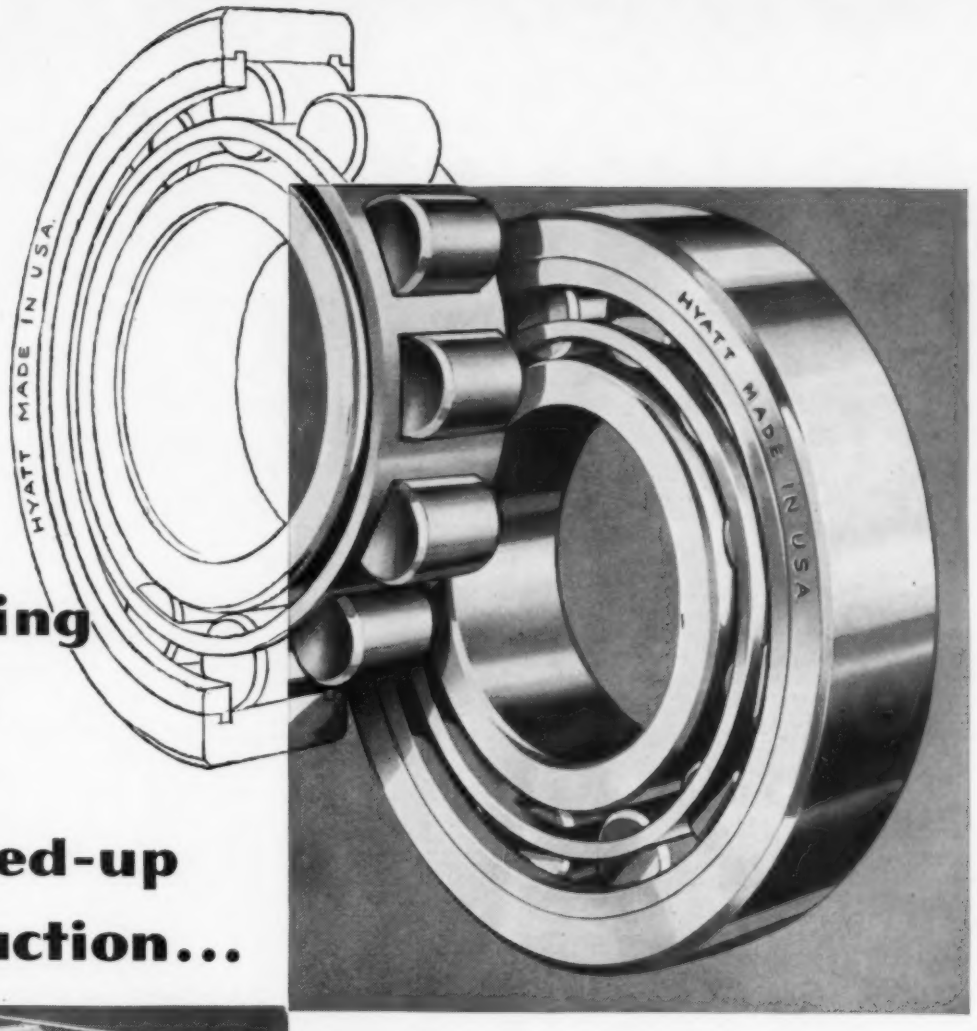
Figure 2 — Scene during second forging heat in 7500-ton press. The once-round ingot has been forged into rectangular shape and is being elongated.

When the forging had been elongated beyond the length of the 37-ft heating furnace, only one end was heated to forging temperature and worked at a time. Hoods of special design were used to retain as much temperature as possible in the section outside the furnace. In preparing for the fifth forging heat, the forging extended across the main bay of the shop and well within an unfired furnace directly opposite the heating furnace.

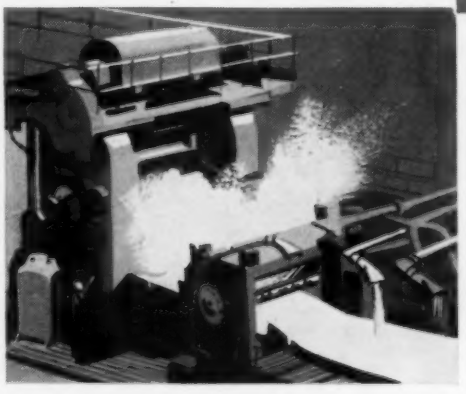
After forging, the big column section was given a one-week heat treatment in a special furnace 120 ft in length designed and built for this job.

A set of three railroad cars was rigged to transport the forging to another section of the plant for straightening in a 6500-ton (straightening) press. Temperature for straightening and annealing to relieve any stress set up in the straightening process was produced in a furnace over 120 ft long specially built for the purpose.

Figure 3 — Fourth forging heat is under the press. The column section has grown to 70 feet in length. Press here is reducing main body width to 44 in.



Keeping pace with stepped-up production...



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HYATT ROLLER BEARINGS

Inland to Develop New Ore Body

▲ A $50,000,000 Canadian iron ore project for Inland Steel Co. was announced on February 25. A Canadian subsidiary of Inland, Caland Ore Co., Ltd., has leased one of the several iron ore bodies owned by Steep Rock Iron Mines, Ltd., in Steep Rock Lake, northwestern Ontario. Test drillings to date indicate at least 50,000,000 tons of ore in the leased area with greater tonnage possible. Quality and structure of the ore is excellent. Inland plans an investment of $50,000,000 over a seven-year period to develop the new ore body. The company expects to attain a shipping volume of 3,000,000 tons of ore annually when in full production.

The agreement between the two companies runs for 99 years and provides for payment to Steep Rock of royalties based on a percentage of the market value of the ore shipped by Inland. Under the terms of the lease, Inland is making a loan to Steep Rock of $8,000,000 repayable after mining operations have commenced. This affords the Steep Rock company additional working capital to speed up development of its own new mines.

The lease marked Inland's first entry into Canada although the company has been participating in exploring ore deposits in Canada for more than 20 years.

Inland's pre-production program of drilling and exploring is continuing on the leased area this winter as it has

Figure 1 — Iron ore body exposed by draining Steep Rock Lake has been leased by Inland Steel Co.'s Canadian subsidiary, Caland Ore Co. Map shows location of Steep Rock on Canadian National Railroad west of Port Arthur, Ontario. Route of ore boats from Port Arthur to Inland's steel mills at Indiana Harbor is shown in comparison with shipping route for Mesabi ores from Superior-Duluth.

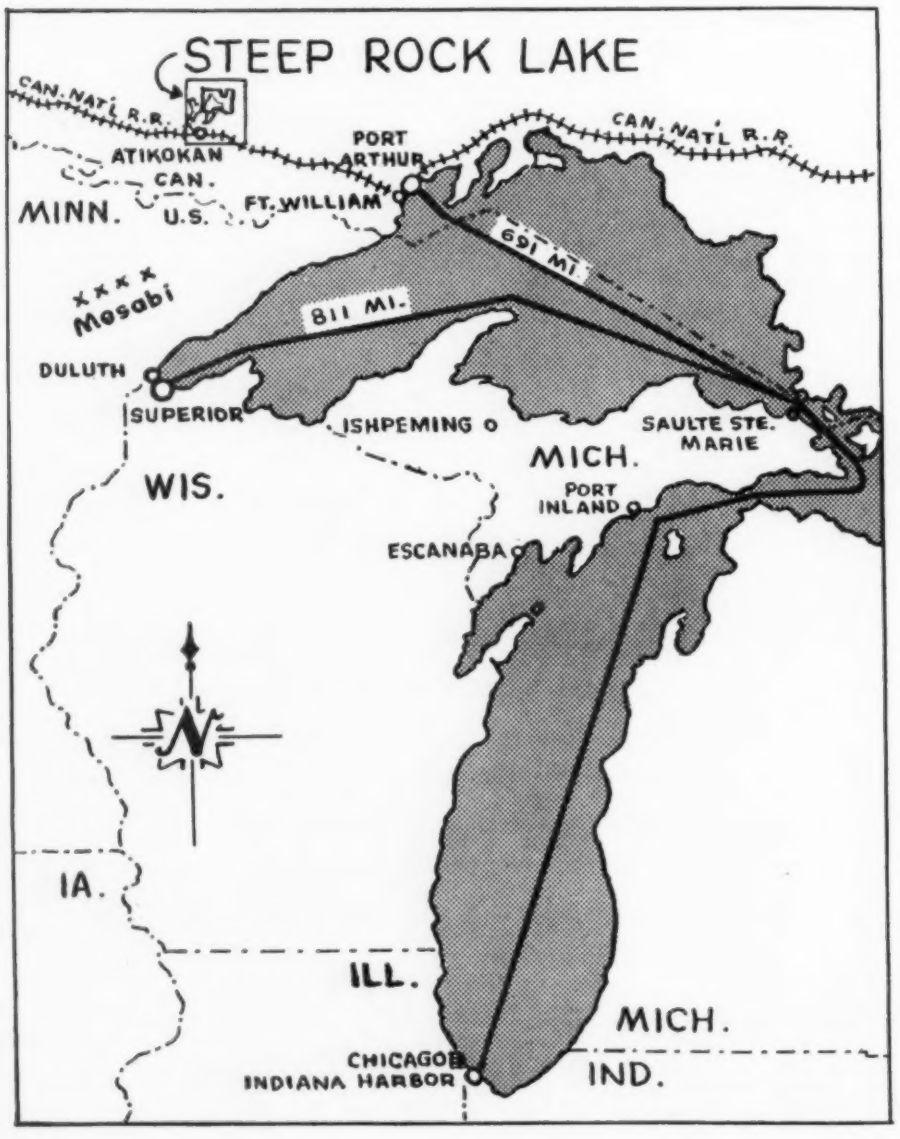
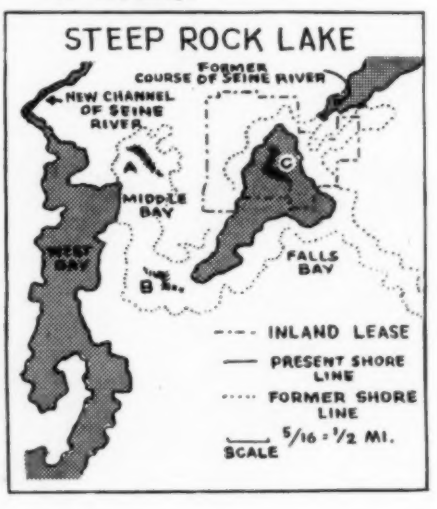


Figure 2 — Enlarged Steep Rock Lake section of big map shows ore body leased by Inland Steel (location "C"). This was made accessible by diverting of Seine River and draining of lake. Steep Rock Iron Mines, Ltd., is producing ore from "B" ore body and is now developing mine in "A" ore body.



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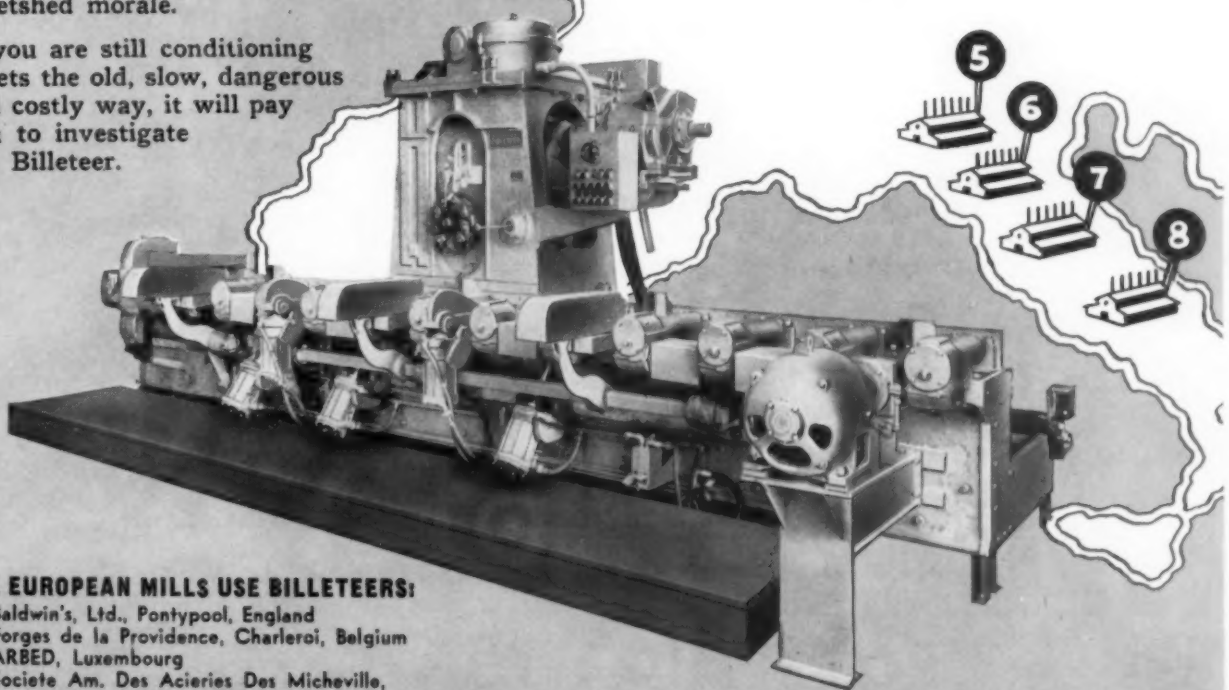

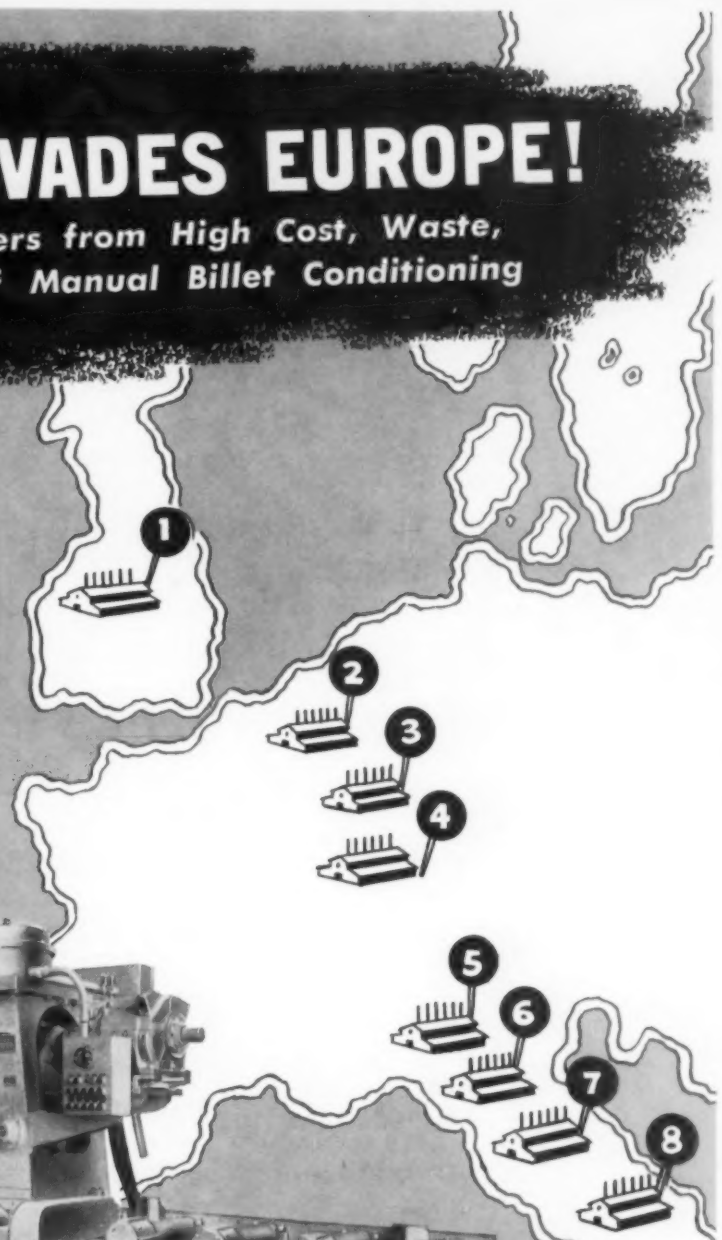

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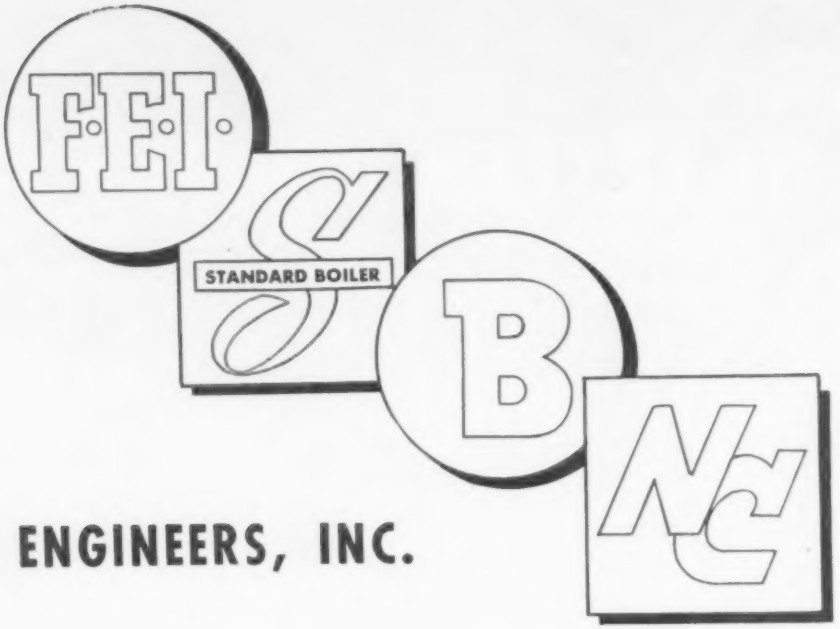

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during the preceding three, and the major undertaking of bringing the Caland mine into operation will be commended as soon as possible. The first phase of the project will be the removal of overburden to expose the ore body for mining operations, probably of the underground type.

Caland will be a Canadian operation in all respects with complete autonomy for development of the property except for overall direction by the parent steel company. So far as possible, all personnel will be Canadian.

The Steep Rock development has special attraction for Inland because of its location. Ore boats will load Steep Rock ore from the Canadian National Dock at Port Arthur. This port is 120 miles nearer the steel mills at Indiana Harbor than Superior, Wisc., shipping point for Mesabi Range ore, which will result in saving almost a day in each round trip.

The properties of Steep Rock Iron Mines, Ltd. are located at Steep Rock Lake, 140 miles west of Port Arthur, Ontario. The range is on the main line of the Canadian National Railways between Port Arthur and Winnipeg. A spur of 3 or 4 miles will connect the Caland ore body with the railroad. The Caland lease covers 1200 acres in the Falls Bay area of the Steep Rock Lake and the Caland deposit, designated as the "C" ore body, is one of the large ore bodies made accessible since 1943 by spectacular engineering operations on the part of the Steep Rock Company, including the diversion of the course of the Seine River away from Steep Rock Lake and the dredging of that lake.

Steep Rock Iron Mines, Ltd. has been producing ore continuously from the "B" ore body in the middle section of the former lake since 1944 and, in addition, is presently developing the large "A" ore body and the newly discovered "G" ore body in the same section.

In 1952 the Steep Rock Company shipped 1,275,000 tons from the Errington open pit in the "B" ore body and is now preparing the Errington underground mine to produce ore down to depths of several thousand feet. Production from this underground mine and from the Hogarth open pit on the "A" ore body is expected to begin this year.

With this acquisition, Inland has gained a strong position in iron ore reserves covering its requirements many years into the future without the necessity of going to remote sources to supplement the reserves it already has in the United States.

NATIONAL TUBE STARTS OPERATION OF NEW EXTRUSION DEPARTMENT

▲ Hot billets of tough stainless steel are rammed through dies to produce tubes and shapes in a new extrusion department at United States Steel Corp.'s National Tube division plant at Gary, Ind. Glass in various forms is melted by the process to act as a high-temperature lubricant for the dies. The new unit, employing the French Ugine Sejournet process for the hot extrusion of metals, consists of a 2500-ton hydraulic press and related facilities.

The press is capable of producing seamless tubing 1½ to 6¼ in., outside diameter. With present tooling, the maximum size extruded is 5⅛ in. Wall thicknesses vary with the size of the tube. Annual capacity of the new unit will depend on the weight of the billets charged and the type of product being extruded. At full production and with a favorable product mix, it is estimated the press will turn out more than 2000 tons a month.

Using the new facilities, the Gary plant can now produce tubing from non-pierceable grades of stainless steel. It can also extrude unusual shapes that cannot be rolled because of their unbalanced design.

Steel billets for the process are supplied by other U. S. Steel mills and arrive in the form of rough-turned and surface-conditioned rounds. These are stored outside the mill in a 6350 sq yd area. They are moved as needed to an indoor storage area where they are weighed before being cut into extrusion slugs.

The cutting is done by four circular saws and there is provision for a future installation of four more. Each saw is serviced by an overhead jib crane. After cutting, the slugs are weighed and in some cases the leading end is chamfered. For production of small tubing of stainless steel the slugs must be drilled. This is done on a vertical drill, inverted to permit the spilling of drill chips. Enough slugs are prepared and stored to fill each order specification.

To make it possible to handle the slugs by overhead conveyor, a specially headed flux-filled stud is welded to the end of each slug by a semi-automatic electric-arc process. Alloy-steel cast hangers, designed to withstand severe and repeated thermal shocks, are suspended from an overhead conveyor similar to those used

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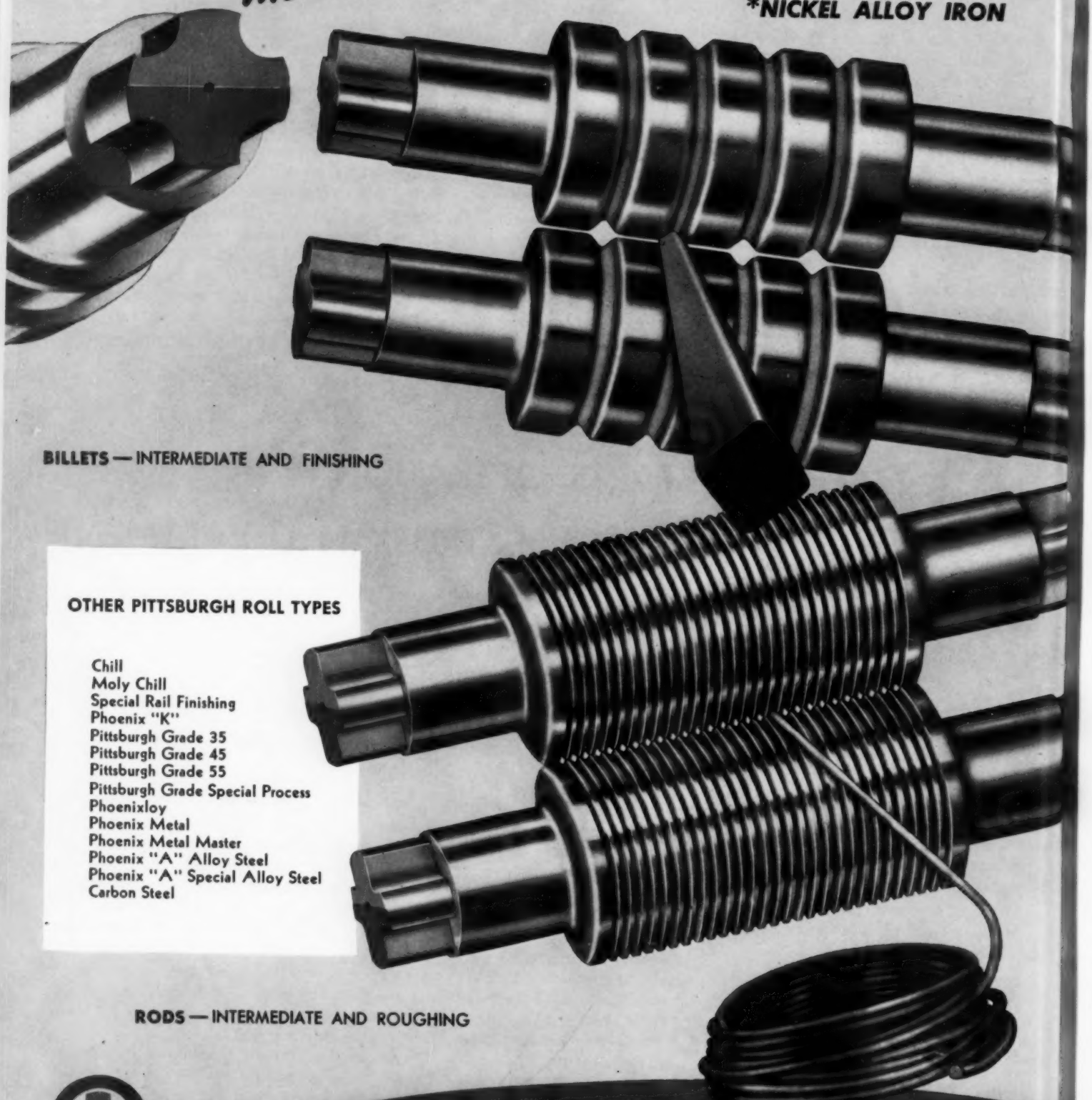

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Phoenix Metal
Phoenix Metal Master
Phoenix "A" Alloy Steel
Phoenix "A" Special Alloy Steel
Carbon Steel

RODS — INTERMEDIATE AND ROUGHING

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PITTSBURGH ROLLS

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Figure 1 — High alloy seamless steel tubing and shapes are produced in a new operation at National Tube division of U. S. Steel Corp.'s Gary, Ind. plant. The operation is expected to produce approximately 2000 tons of seamless steel tubing and shapes a month.

on automobile assembly lines. The stud is engaged by a slot in the hanger and the conveyor moves the suspended slug into the heating furnace. This is a 3-zone, gas-heated furnace with a slotted roof to permit passage of the necks of the hangers. The furnace can produce maximum temperatures of 2400 F. From the furnace the conveyor carries the slug to a barium chloride bath where temperatures up to 2300 F may be maintained.

Extruding temperatures vary with the type of stainless steel being used but the average is around 2250 F. Slugs are heated in the gas furnace to nearly final extrusion temperature before transferring to salt bath.

The salt bath completes the heating of the slug and coats the billet and reduces any surface scale which has formed. An exhaust and ventilation system protects employes from fumes and excessive heat.

After leaving the barium chloride pot, the heated slug is conveyed to a charging buggy. Here the welded stud is severed with an air-driven chisel. The slug drops onto the press charging buggy, which positions the billet in the press. A sheet of glass fiber is placed on the table and wraps around the slug as it rolls into position before the extrusion press.

The press itself is prepared in advance for each extrusion. The die is placed in position and the slug case packed with sandwiches of various thicknesses of woven, pane, spun or other forms of glass, depending on the type of extrusion and the composition of the steel. The face of the ram is protected by a removable steel disc called the "dummy block." In extruding tubes, the major product of the National Tube division, a mandrel, projecting through and beyond the ram, is covered with a glass-fiber stocking.

In some cases it is possible to use the mandrel as a piercing tool, eliminating the need for drilling the slugs beforehand. This practice is limited to large-diameter tubes because of the structural strength limitations of the mandrel.

A special air cylinder on the charging buggy inserts the prepared slug into a heavy, circular steel section known as the "container." A spacer piece is lowered before the face of the container, the ram is advanced and pressure is applied. Heat and pressure reduce the glass to a viscous liquid which serves as a lubricant as the steel is forced through the die.

The main ram is powered by a 2000-ton hydraulic cylinder and the piercing mandrel by one of 500 tons, providing a total available force of 2500 tons. Power for the press and auxiliary equipment is transmitted through a closed hydraulic system using a solution of city water and soluble oil as fluid. A pre-fill tank of 1200 gal and a gravity tank of 6800 gal provide a total fluid capacity of 8000 gal. There are two hydropneumatic accumulator systems, each with a maximum pressure capacity of 3900 psi, or 300 lb over the maximum operating pressure requirements of 3600 lb. An air compressor, with 4000 psi maximum capacity, is provided for charging and recharging air to the accumulators.

After the slug has been extruded there remains in the container the unextruded portion, or butt. This is usually less than ¾-in. long. The container is shifted away from the die approximately 4 in. This draws part of the extruded tube back through the die and provides space for a high-speed circular saw to cut the butt from the tubing. The container is advanced again to push the severed tube onto an outlet conveyor. The butt is then pressed from the container by the rammer. It falls into a chute which conveys it to an operator who removes the butt from the dummy block by a hydraulic squeezing mechanism. Butts are recovered for scrap, the dummy blocks for re-use.

The extruded product leaves the die by means of an outlet conveyor. This is followed by a table from which the product can be dropped into a water-quench tank or onto an air-cooling rack. After either quenching or air cooling, the product is weighed and inspected. At present, some shapes have a tendency to twist as they leave the die. After cooling and inspection, these are moved to a stretch straightener where such objectionable characteristics are corrected.

Glass and oxides adhering to extruded tubes are removed by a bath in a special pickle solution. After rinsing, the tubes are ready for further processing—either tube reducing or cold drawing.

The dies in the extrusion press become thinly glazed after each operation and must be cleaned before reuse. Thus, three dies must be used in cycle: one in the press, one being cleaned and one in reserve. The container is also cleaned with a rotary brush after each extrusion. The press and its auxiliaries are fully instrumented and all controls are automatic.

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To clean their stoves, *and keep them clean*, many operators rely on Dowell chemical cleaning service. That's because Dowell's record for service work of this kind is outstanding in the industry. On one job, for instance, chemical cleaning by Dowell helped raise the gas heating efficiency of a blast furnace stove from 63.6% to 82.7%. What's more, the cleaning was accomplished *in two working days without dismantling the stove!* Dowell Service engineers used a high-pressure solvent jet, which combines chemical and hydraulic action to clean the brick checkerworks.

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Date-line Diary...

February 2

▲ Based on reports from companies having 93 per cent the steel capacity for the industry, the operating rate for the week beginning February 2 is scheduled at 95.6 per cent of capacity. This is equivalent to 2,154,000 tons of steel ingots and castings compared with actual production of 2,240,000 tons one week ago.

▲ The DPA announced that the Aluminum Co. of Canada and the British government at the request of the United States government have agreed to supply 44,000,000 lb of aluminum for delivery in February and March. If the British government requires repayment, U. S. producers will sell back equal quantities during 1954 and 1955.

February 3

▲ The Commerce and Labor Department reported that new construction put in place in January was worth $2,300,000,000, or a 6 per cent increase over the same period one year ago.

▲ The price of lead dropped ½¢ to 13½¢ a lb in New York.

▲ The Board of Directors of Acme Steel Co. of Chicago, Ill. declared its 295th consecutive dividend payment since 1901 with a quarterly payment of 40¢ per share.

February 4

▲ Koppers Co., Inc. has been awarded a contract by Weirton Steel Co. to design and build 41 chemical-recovery coke ovens for the Weirton, W. Va. plant.

▲ At Armco Steel Corp.'s Middletown, Ohio plant, the lighting of 76 coke ovens took place.

▲ The Commerce Department reported United States manufacturers sold $276,500,000,000 worth of goods in 1952, or a 3 per cent increase over the previous year. The backlog of orders for manufacturing firms totaled $71,500,000,000 as of December 31, 1952, and year-end inventories were estimated at $43,-600,000,000.

▲ The price of zinc dropped ½¢ to 11½¢ a lb in East St. Louis.

February 5

▲ The Senate Finance Committee approved a bill permitting duty-free copper imports until June 30, 1954.

▲ Directors of the Cleveland-Cliffs Iron Co. have approved development of a low grade ore program at its Republic mine in Michigan.

▲ The 5-day wildcat steel strike ended at Inland Steel Co.'s, Indiana Harbor works. It is estimated that 70,000 tons of steel were lost during the strike.

▲ The price of deadburned grain magnesite, standard grain, f.o.b. Chewalah, Wash., in bulk has been increased $1.70 to $38 per ton by Harbison-Walker Refractories Co.

February 6

▲ The NPA announced the decontrol of tin in the United States, and that it may now be purchased in any amount for any purpose, however, consumers and dealers must submit monthly reports.

February 7

▲ President Eisenhower eliminated all wage and salary controls, and removed price controls for a variety of consumer goods.

▲ The Commerce Department reported that employment in January 1953 totaled 60,524,000 or 750,000 more than January 1952.

February 9

▲ Senator Taft stated that tax reductions should be voted in 1954 to take effect in the fiscal year starting July 1, 1954, and said that it would be "unwise" to cut individual taxes this year. He predicts a 10 per cent drop in the number of government employees due to Budget Director Dodge's cutback order.

▲ Under a ruling by the NLRB competing unions cannot stage representation elections in plants during the full term of an agreement covered by five year labor contracts.

▲ The Census Bureau reported that sales in 1952 in retail stores totaled $164,000,000,000, or 4 per cent higher than in 1951.

▲ Based on reports from companies having 93 per cent capacity of the steel industry, the operating rate for the week beginning February 9, 1953 is scheduled at 98.7 per cent of capacity. This is equivalent to 2,226,000 tons of steel ingots and castings compared with actual production of 2,202,000 one week ago.

▲ The Aluminum Association reports that production of primary aluminum for the United States in 1952 reached a total of 1,874,642,692 lb, or 12 per cent greater than 1951. Shipments of sheet and plate for 1952 totaled 1,071,976,000 lb.

February 10

▲ The Commerce Department reported that business inventories at the end of 1952 were valued at $73,300,000,000.

February 11

▲ A bill continuing the suspension of tariff duties on imported copper was passed by the Senate and sent to the White House.

▲ The Commerce Department reported that personal income for 1952 in the United States rose to a new high of $268,500,000,000, or 5½ per cent above 1951. In 1952 income after taxes reached $234,000,-000,000, or 4 per cent lower than in 1951.

▲ According to the ARCI, new domestic freight car deliveries for the month of January amounted to 7981, compared with 7845 in the previous month. New orders for freight cars in January totaled 5536, and the backlog of cars on order was 77,414 as of February 1.

February 13

▲ Effective April 1, the government will relax its system for rationing steel.

▲ A proposed 10¢ West Virginia state tax per ton of coal mined received the support of John L. Lewis and the United Mine Workers Union.

▲ According to preliminary figures, Acme Steel Co., Chicago reports sales for 1952 totaled $57,967,395, and net earnings amounted to $4,568,577, or $2.30 per share of common stock.

▲ The F. W. Dodge Corp. announced construction contract awards for the thirty-seven states east of the

Rockies in January of $1,075,868,000, or 19 per cent higher than January 1952.

▲ David J. McDonald has been elected to succeed Philip Murray as president of the CIO steelworkers in the United States and Canada.

February 14

▲ Acting Defense Mobilizer Fleming announced that allocations of steel, copper and aluminum under the Controlled Materials Plan will be discontinued on June 30.

▲ The Petroleum Administration for Defense lifted the curbs on natural gas expansion.

February 16

▲ Based on reports from companies having 93 per cent the capacity of the steel industry, the operating rate for the week beginning February 16 is scheduled at 99.7 per cent of capacity. This is equivalent to 2,248,000 tons of steel ingots and castings compared with actual production of 2,248,000 tons one week ago.

February 17

▲ Yngvar Brynildssen, Acting Administrator of the SDPA, reported that approximately $311,000,000 in military contracts have been set aside for small business.

February 18

▲ The quarterly dividend in March was increased to $1.00 by Republic Steel Corp.

▲ Robert H. Winters, Resources and Development Minister of Canada, reaffirmed the decision of the Canadian government to reject Alcoa's bid to divert head waters of the Yukon River for power. The House of Commons in Ottawa was informed by Mr. Winters that a survey permit for the same purpose had been granted to Quebec Metallurgical Industries, Ltd, a subsidiary of Frobisher, Ltd.

▲ 1952 sales for Armco Steel Corp. were $518,575,218. Net earnings after taxes for 1952 were $31,337,861 or $6.01 per share of common stock compared with $6.69 in 1951.

▲ Crucible Steel Co. of America announced net sales for 1952 of $180,266,000, and net income after taxes of $5,394,000. This is equivalent to $6.13 per share on common stock compared with $10.76 in 1951.

February 19

▲ The No. 1 blast furnace of Woodward Iron Co. at Woodward, Ala. went back into operation after being down for repairs since January 10.

▲ A fifteen man advisory committee composed of five members each for management, labor and the public has been created by Labor Secretary Durkin, and is scheduled to meet on February 24 to begin work on proposed amendments to the Taft-Hartley Law.

▲ The Commerce Department reported United States exports for 1952 exceeded imports by $4,500,000,000.

▲ The Small Defense Plants Administration has set a ceiling of $300,000 on individual loans to small business effective immediately.

February 20

▲ President Ibanez of Chile disclosed he will not nationalize the copper or nitrate industries in his country.

February 21

▲ Ford Motor Co. will spend at least $500,000,000 in the next three years for plant expansion.

▲ Republican Senator Ives of New York proposed eliminating the 80-day injunction procedure of the Taft-Hartley Act, which was immediately opposed by Senator Taft.

▲ Ward's Automotive Reports predict automobile output for the first six months of 1953 will reach a high of 3,200,000 cars.

February 24

▲ The Labor Department reported average hourly earnings for factory workers rose 18¢ to $1.73 an hr in a two year period which ended January 15, 1953.

▲ Based on reports from companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning February 23 is scheduled at 99.5 per cent of capacity. This is equivalent to 2,244,000 tons of steel ingots and castings compared with actual production of 2,235,000 tons one week ago.

February 25

▲ According to the Commerce Department the nation's production of goods and services reached $346,000,000,000 for 1952, or a 5 per cent gain over dollar volume in 1951.

▲ Westinghouse Electric Corp. reports net sales of $1,454,272,000 for 1952, and net income of $68,581,000. This is equivalent to $4.23 per share of common stock.

▲ As a result of a reduction in stock margin requirements from 75 to 50 per cent the stock market scored general advances.

February 26

▲ Kennecott Copper Corp. raised the price of domestic copper 3¢ to 27½¢ a lb shortly after price controls were removed.

▲ The price of zinc dropped ¼¢ to 11¼¢ a lb in East St. Louis.

February 27

▲ The AISC announced January bookings of fabricated structural steel totaled 268,163 tons, or a 26 per cent increase over the same period one year ago. Shipments for January totaled 234,234 tons. Backlog as of January 31 stands at 2,179,777 tons.

▲ Mesta Machine Co. reports net income for 1952 of $2,709,597, which is equivalent to $2.71 per share on common stock compared with $3.81 in 1951.

▲ According to the AISI, finished steel product shipments in 1952 totaled 68,003,612 tons, or 11,000,000 tons less than 1951. The drop was the result of the steel strike. Manufacturers of direct military items such as tanks, shells and guns, despite the reduced total supply, received approximately 2,100,000 tons of steel in 1952.

February 28

▲ Pittsburgh Coke & Chemical Co. in its annual report announced net profit for the year 1952 of $2,163,000, or equivalent to $2.12 per share on common stock compared with $3.65 in 1951. Sales for the year totaled $38,700,000.

▲ Secretary of Agriculture Benson promised to support butter and other dairy products at 90 per cent parity for another year.

▲ Eugene Grace, chairman, Bethlehem Steel Corp., prophesied 1953 would be the best year in Bethlehem's history. He stated also that total income for 1952 was $1,701,541,383, giving a net income of $90,900,771 or $8.80 a share compared with $10.43 a share in 1951.

▲ Youngstown Sheet & Tube Co. lit a new blast furnace this week at its Indiana Harbor, plant. This furnace has a capacity of 1600 tons daily.

CALL Curry! FOR STEEL PLANT EQUIPMENT

FOR SALE—Immediate Delivery!
REVERSING COLD REDUCTION MILL

Available for immediate delivery — at great savings in cost — this 2½" dia. and 20" dia. x 7½" face, 4 Hi Reversing Cold Reduction Steckel Mill illustrated right is a complete operating unit, with mechanical and electrical equipment including motor-generator set and spare parts. Call, write or wire today.

CALL CURRY on the following good, usable equipment:

2000 H.P., G.E. SLIP RING MILL TYPE MOTOR, 3/60/2300 v 237 RPM, complete with Liquid Slip Regulator and all controls necessary for mill type operation, including Filtered Air Cooling System.

75-TON MORGAN LADLE CRANE. WITH 25-TON AUXILIARY. 4-Girder Construction. Span 49'6". Motors & Controls for 230v. DC operation.

18"/21" 3-HIGH BAR MILL, complete with Pinion Stand, Gear Reduction Unit, 2500 H.P. Motor, Billet Heating Furnace, Tables and Electric Equipment.

80" HYDRAULIC STRETCHER LEVELLER, Capacity 80" wide x 200" long, complete with all Hydraulic Pumps, Controls, and Motor.

400 H.P. GEAR REDUCTION UNIT (WESTINGHOUSE), Single Reduction, Helical Gears, Ratio 6 to 1.

600 H. P. GEAR REDUCTION UNIT (FARREL-BIRMINGHAM), Ratio 2.95 to 1, Single Reduction, Rebuilt 1950.

300 H.P. GEAR REDUCTION UNIT (LEWIS FOUNDRY & MACHINE CO.), Ratio 13.5 to 1, Double Reduction.

PORTABLE ALLIGATOR CROP SHEAR 7½" Knives, Reconditioned.

D & K No. 2 ALLIGATOR SHEAR, 21" Knives, 7½ H.P. 3/60/220-440V Motor.

5 TON OVERHEAD ELECTRIC CRANE, 47' Span D.C. Cab Operated.

Write today for the Curry List of Available Steel Plant Equipment!

ALBERT Curry & CO., INC.

STEEL PLANT EQUIPMENT

Cable Address — Curmill Pittsburgh

940 OLIVER BUILDING • PHONE ATLANTIC 1-1370
PITTSBURGH 22, PA.

INSIDE AN EXIDE-IRONCLAD

Inside . . . where it counts most . . . EXIDE-IRONCLAD is entirely different than any other battery. It's made that way by EXIDE'S exclusive IRONCLAD slotted-tube construction . . . a principle that provides direct operating-hour savings for you.

OF ALL BATTERIES, ONLY EXIDE-IRONCLADS HAVE POWER TUBE POSITIVES

The positive plate is different . . . unique . . . exclusive. It is the most effective retainer of active material yet demonstrated in heavy duty service. Slotted tubes contain the active material. So fine are the slots that, while permitting easy access of electrolyte, they retard the active material from washing out, hold it during repeated cycles of charge-discharge, and the vibration of rough use.

Today's battery-powered equipment is being used harder than ever before. Unless the batteries have internal shock protection they tend to deteriorate under hard usage—both electrical and mechanical. Only Exide-Ironclad has the plus-protection of the tubular positive that can withstand today's more exacting and rigorous heavy-duty battery services.

Your EXIDE sales engineer will give you the factual inside story. See for yourself why *only* an EXIDE-IRONCLAD gives maximum day-after-day service under the most difficult operating conditions . . . *with a minimum of maintenance expense.*

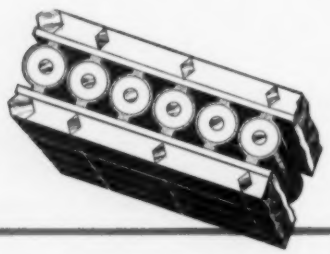
THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 2
Exide Batteries of Canada, Limited, Toronto

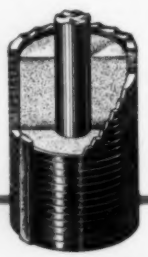
1888 . . . DEPENDABLE BATTERIES FOR 65 YEARS . . . 1953

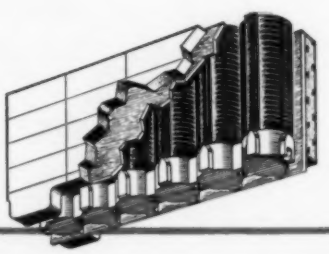
Cross section shows relation of positive plate to separators and negative plate. Note the much greater exposure of active material to electrolyte as compared with that of the usual flat positive plate. This greater exposure makes possible the high power ability and uniform-voltage characteristics of the Exide-Ironclad. The negative plates have been made extra heavy to balance the increased capacity of the power tube positives.

Running through center of each tube is an alloy core which is cast with the heavy top cross bar. These form the sturdy, non-buckling grid. Both core and top bar are made of Exide's new corrosion-resistant Silvium, an alloy of silver, lead and other components, which adds greatly to plate's long life.

New polyethylene insulating tube sealer of acid-proof, non-corroding plastic fits snugly into bottom of slotted tubes and further reduces loss of active material. Thus more active material remains available, and the high battery capacity is maintained for a longer working life.



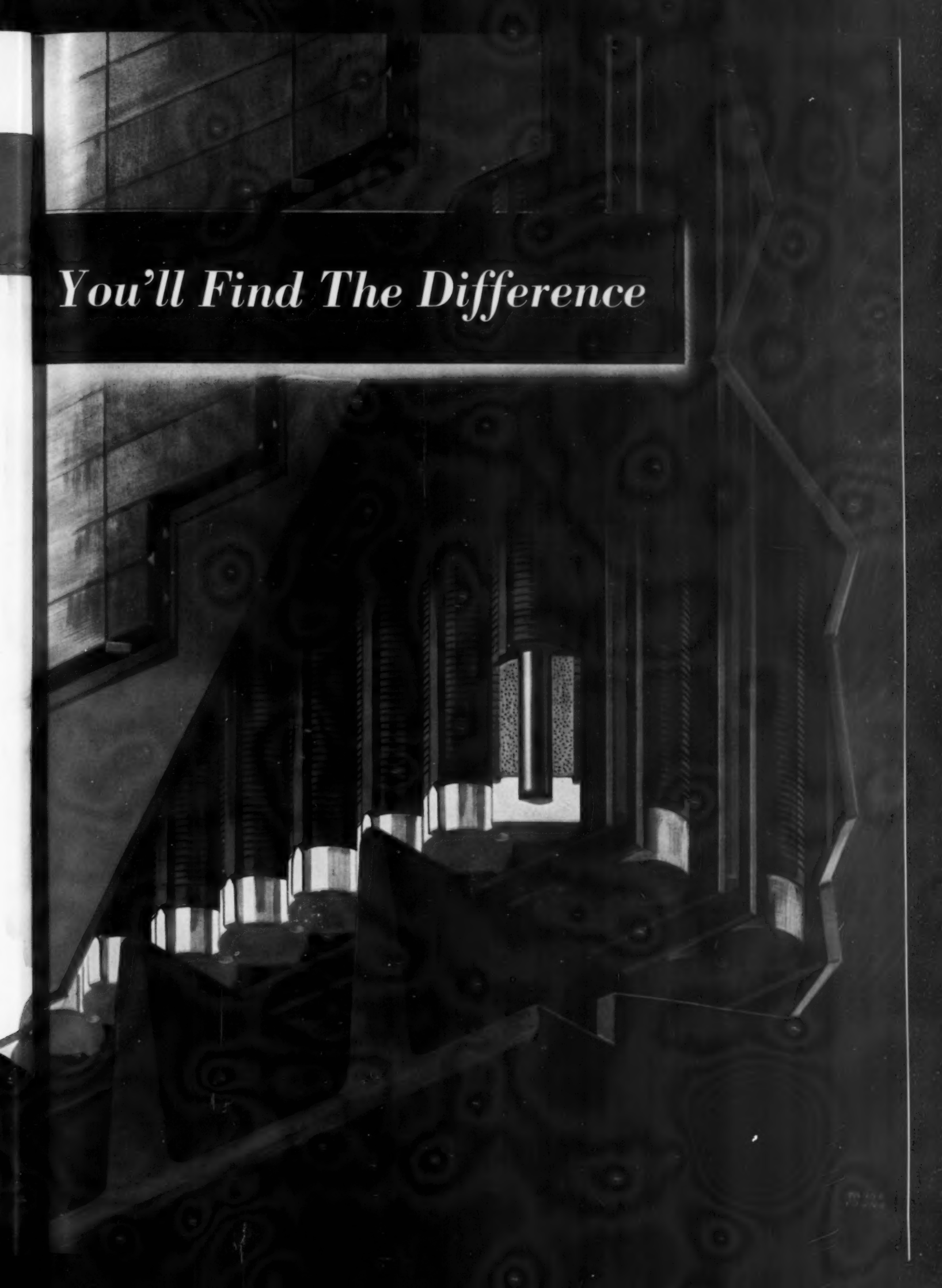




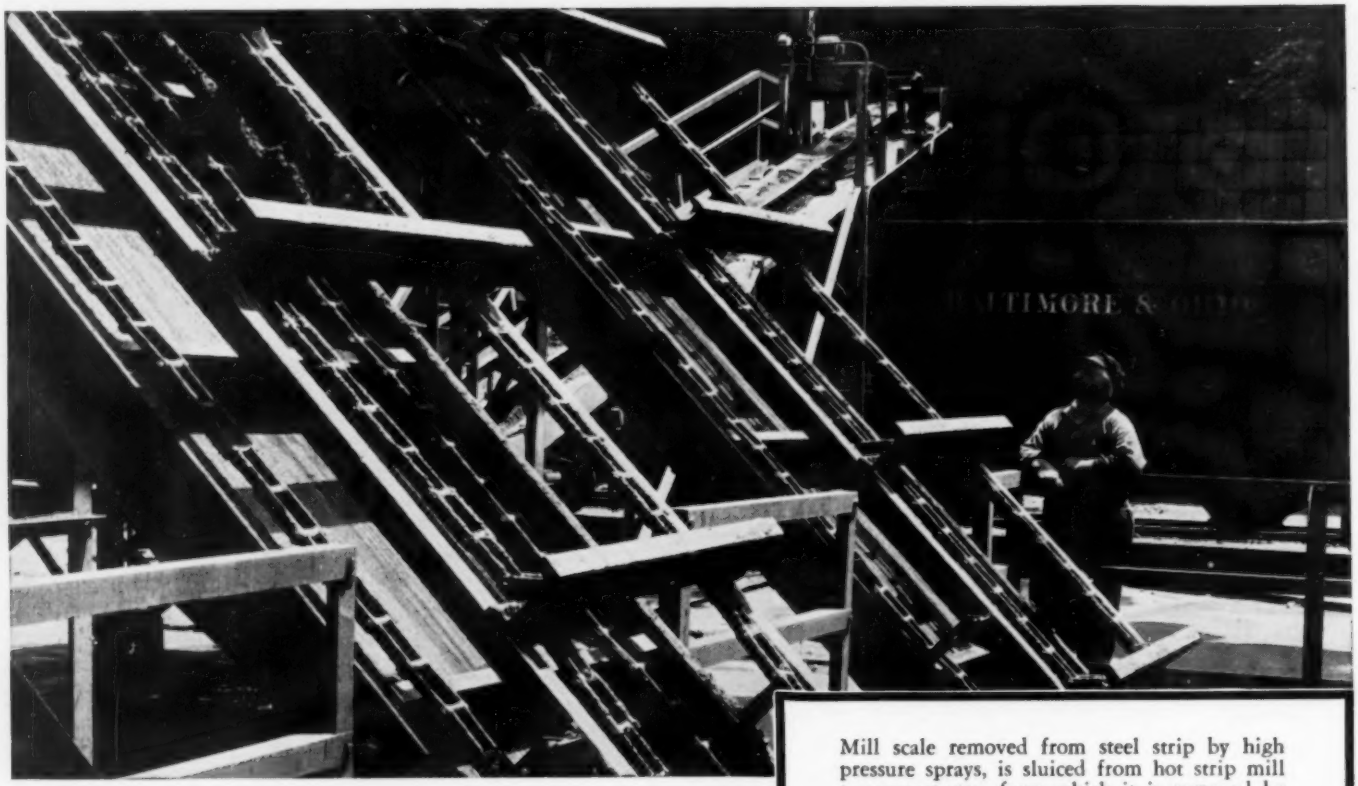
Exide-Ironclad

YOUR BEST POWER BUY . . . AT ANY PRICE

"Exide-Ironclad" and "Silvium" *Reg. T.M. U.S. Pat. Off.*


You'll Find The Difference

Boosts mill scale recovery from 250 to 475 tons a week



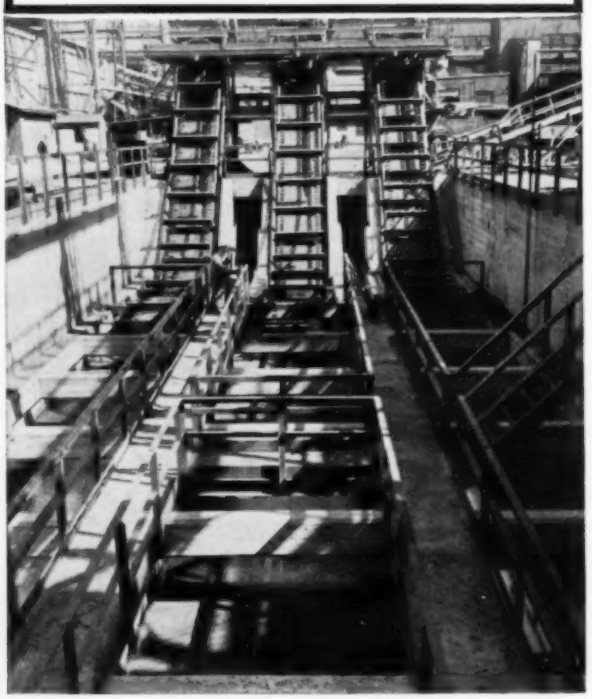
Mill scale removed from steel strip by high pressure sprays, is sluiced from hot strip mill to concentrator, from which it is removed by three Link-Belt Straightline Collectors. Two Link-Belt belt conveyors—a horizontal collecting belt and an inclined pivoted loader—then carry scale to railroad cars. After fusing by sintering, the recovered scale is charged into blast furnace.

Steel mill also eliminates clogged sewers with LINK-BELT Straightline Collectors

HERE'S the case of a mill that saw its profits literally "going down the drain"—and did something about it. Before installing Link-Belt Straightline Collectors, almost half the scale passed into the sewers, causing frequent clogging.

Now, with their new collectors, they've boosted recovery from 250 to 475 tons a week. Since the scale is 72% pure iron, each ton is equivalent to 1½ tons of ore. And the waste water is actually clearer than the river water . . . aiding the anti-river-pollution program.

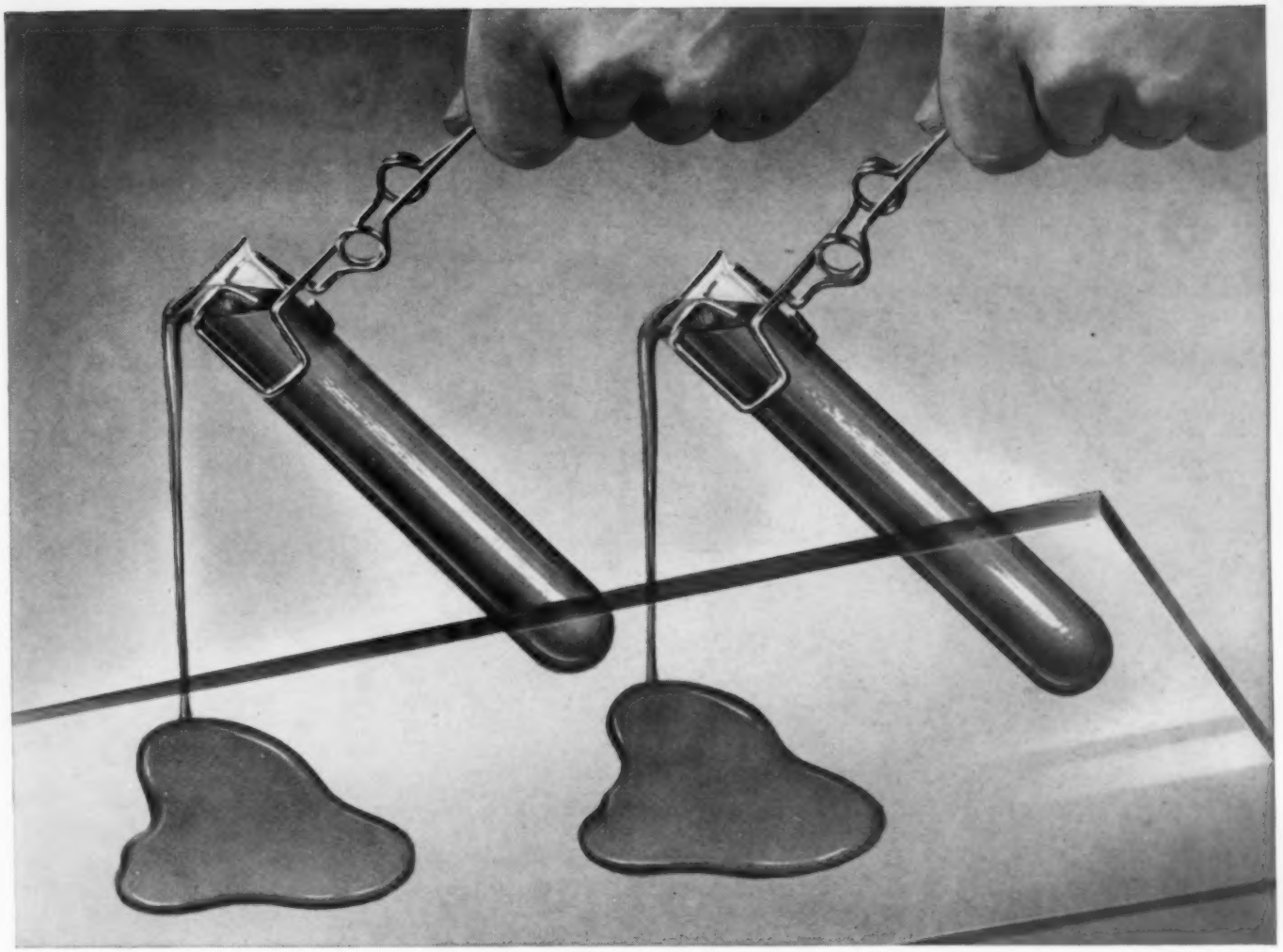
No matter what your waste treatment problem, you'll find it pays to call in a Link-Belt engineer. Drawing on Link-Belt's broad experience in this highly specialized field, he can recommend the equipment best suited to your requirements from the complete Link-Belt line. Ask your Link-Belt office for further information.



LINK-BELT

CONVEYING AND HANDLING EQUIPMENT

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia).
Sales Offices in Principal Cities. 13.094



Which lubricant has increased tin plate production 15%?

Both lubricants look, feel and act alike — yet tin plate mills using the one on the right—Palmoshield—have increased production as much as 15%.

A leading steel company adopted Palmoshield for cold rolling operations and recently over a run of 20 consecutive shifts, production was stepped up 15% over the average output with imported oil. This increase was made with no additional investment, no increase in labor force, no extra machines and no changes in mill operation. Yet 115 tons of steel were rolled for every 100 before.

Nearly two-thirds of the major tin plate mills in this country and Canada are now using Palmoshield for regular mill operations or on-the-job-test runs.

Advantages of Palmoshield

Palmoshield is produced in the heart of the steel industry. Users are not dependent on overseas shipment from foreign controlled sources.

Palmoshield is made from domestic materials freely available in sufficient quantities to supply all American steel production.

Palmoshield need not be stockpiled by the user, yet it does not deteriorate in storage.

Palmoshield is tailor-made to your needs. Free fatty acid content can be controlled to within ½%.

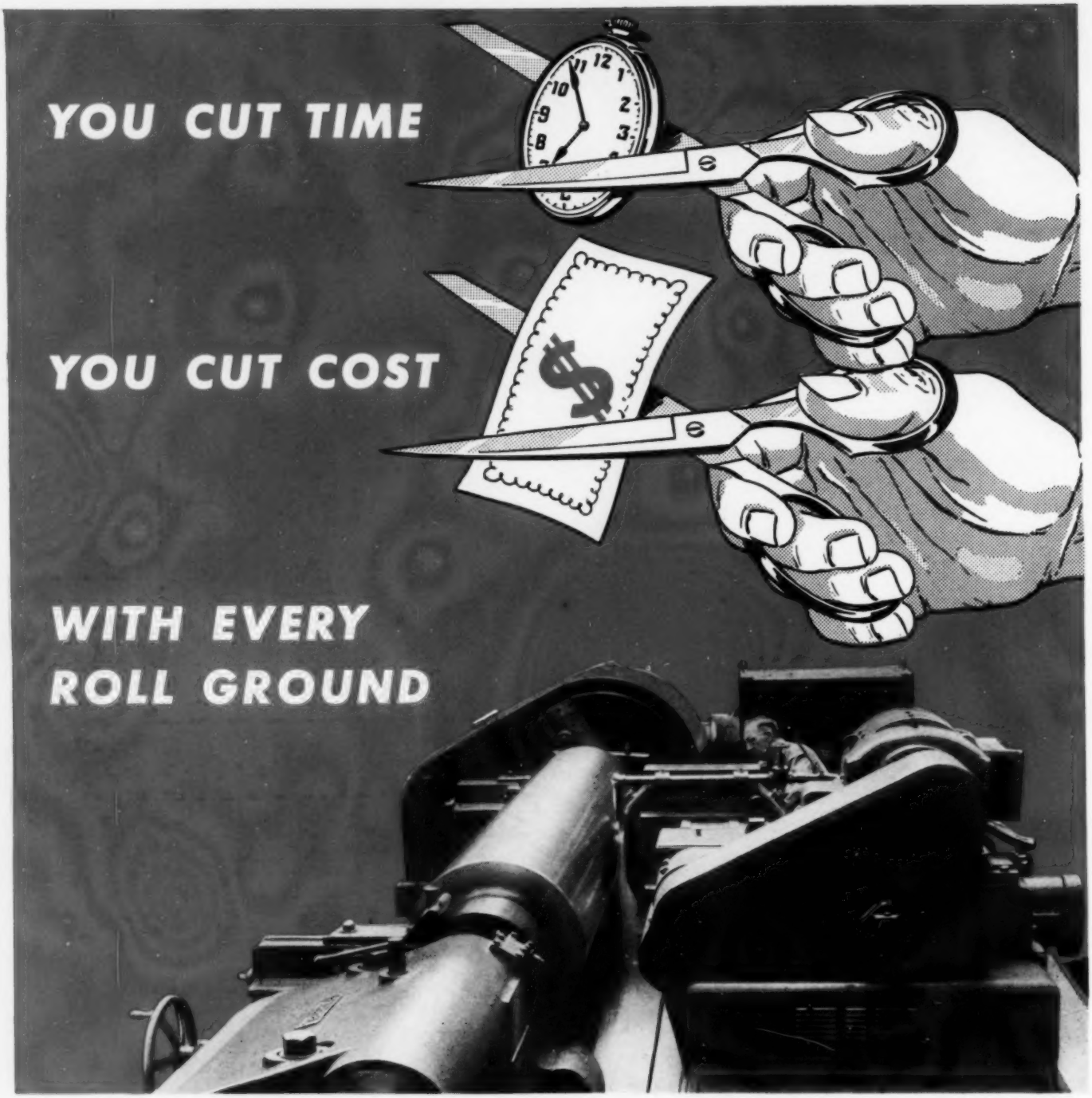
Technical assistance for your own operations.

On request an Ironsides representative will give you facts on Palmoshield to help you set up a test program in your mill.

Palmoshield is available for same-day shipment in 55-gallon drums and tank car lots. For full information write The Ironsides Company, 270 West Mound Street, Columbus, Ohio.

SPECIAL LUBRICANTS and PRESERVATIVES

IRONSIDES SHIELD PRODUCTS PALMOSHIELD



ON A FARREL MACHINE

Users of the latest type Farrel roll grinders find the machine extremely fast for either heavy roughing or producing as high a mirror finish as it is possible to obtain with wheels at present available. Many automatic features simplify both set-up and operation. Setting-up time is held to a minimum.

Faster grinding means less labor per roll ground, which cuts the cost of grinding. Furthermore, because of the exceptionally smooth and vibration-free action in roll, wheel and traverse drives, less metal has to be removed to clean up a roll in roughing and finishing operations. This reduces the frequency of roll replacement and, consequently, the cost of new rolls.

Send for further information about these time-saving, cost-cutting roll grinders. They are available in two types—type HD shown here, and type TT with traveling work table. Bulletins giving complete specifications of either type will be sent promptly on request.

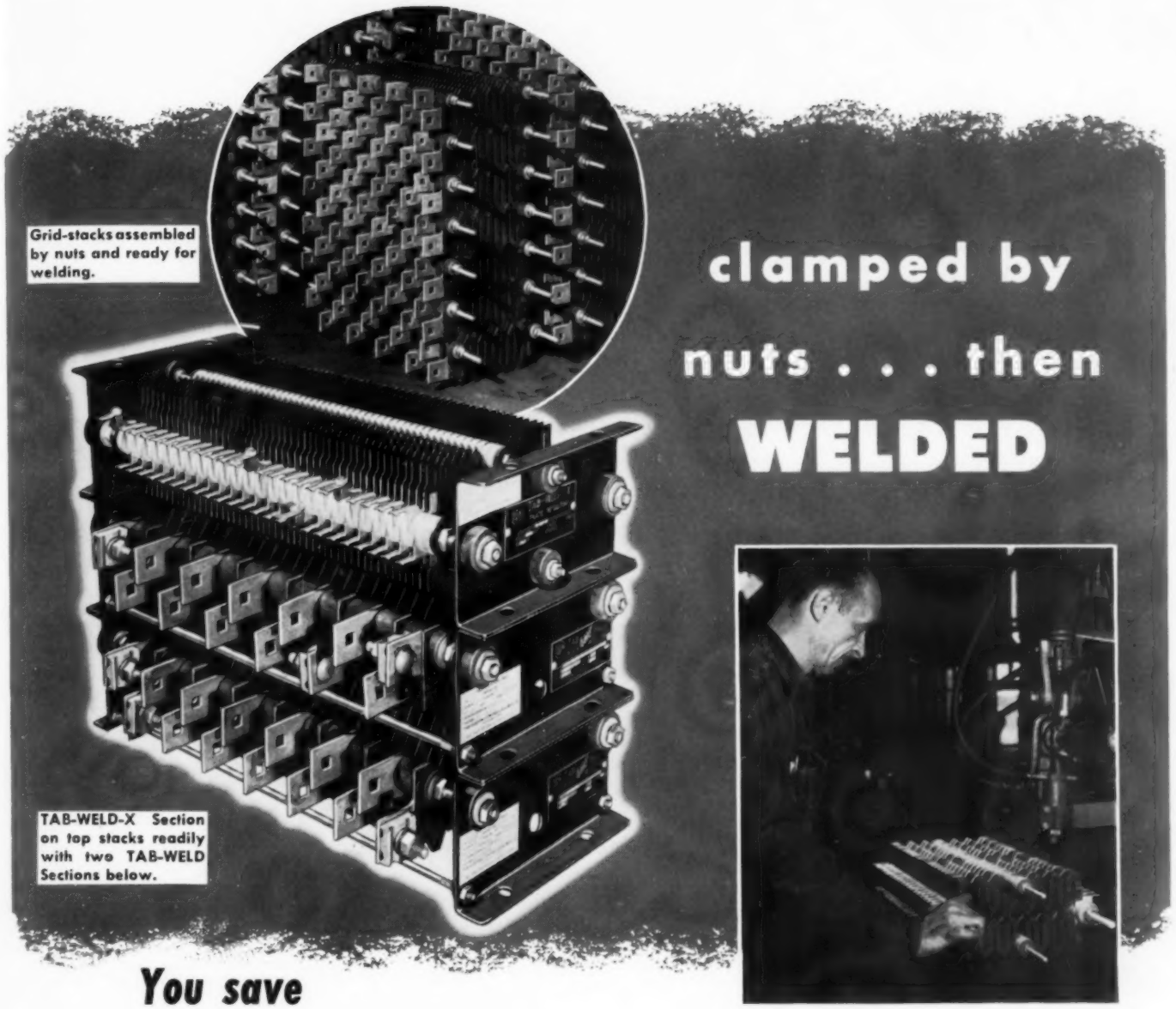
FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

FB-748

Farrel-Birmingham®


Grid-stacks assembled by nuts and ready for welding.
TAB-WELD-X Section on top stacks readily with two TAB-WELD Sections below.
clamped by
nuts . . . then
WELDED

Spot-welded to insure continuous current-path.

You save on UPKEEP with this added feature

EC&M TAB-WELD Plate Resistor Sections are assembled on rods to form the grid-stack like any other grid section. Clamping-nuts squeeze the grids into intimate contact internally before the end-frames are added.

Then, in these EC&M sections, the tab-ends of adjacent grids and tap-plates are *welded* to maintain intimate contact and to eliminate burning at the grid-eyes and at the tap-plates. This is an exclusive EC&M feature. Tests show that welding stabilizes the OHMIC value of the section, independent of clamping-nut pressure.

In addition, EC&M TAB-WELD Plate Resistors can be used without alteration, from the storeroom shelf. On-the-job connections are easily made to any of the tap-plates . small adjustments in resistance-value readily available by moving only the external-lead and terminal-block.

SPECIFY

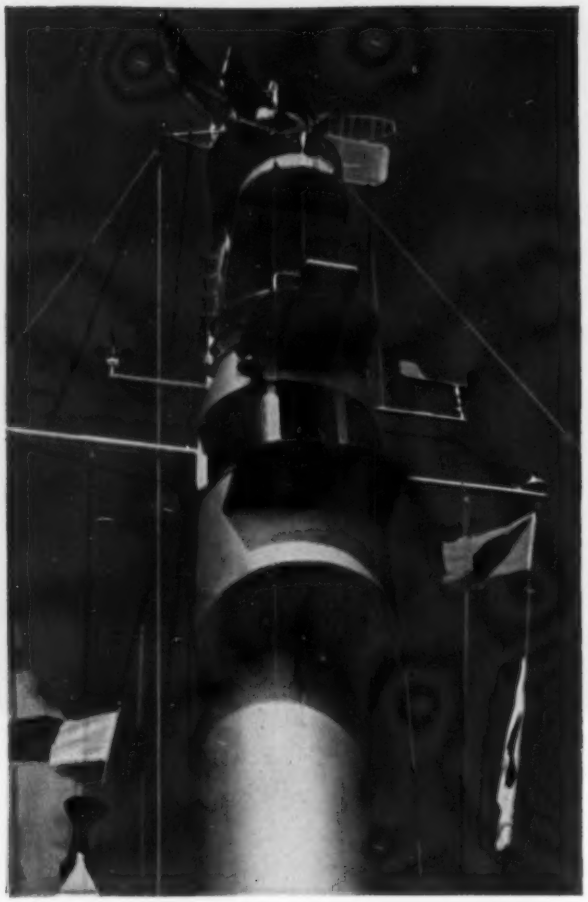
EC&M BULLETIN

942

WELDED PLATE RESISTORS

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET ★ CLEVELAND 4, OHIO



Dramatic radar tower of the S. S. United States. The ship was designed by Gibbs & Cox, Inc., built by Newport News Shipbuilding and Drydock Co., and is operated by U. S. Lines, Inc.

S. S. UNITED STATES MADE WITH BRICK!

BRICK! Symbol of superiority among the world's merchant marine fleets. The fastest and safest passenger liner afloat. Flagship of American production . . . made with brick.

Refractory brick, that produced the thousands of tons of steel for the mighty S.S. United States. For her gigantic hull and the thousands of components . . . all made from steel, the metal that has established America as the industrial leader of the world.

In every type of furnace used in a steel mill, you will find refractory brick produced by GREFCO. The coke ovens that make the fuel for blast furnaces are built of silica and fireclay brick, while coke chutes and hoppers give trouble-free service when lined with CARBEX silicon carbide. A long-time standard of quality in coking chambers is GREFCO's silica brick. The same eminent position is occupied by GREFCO fireclay brick in other parts of the ovens. Both GREFCO silica and

fireclay brick are produced in strategic locations throughout the country.

In blast furnaces it's OLIVE HILL all the way. Hard fired, dense OLIVE HILL, a special high duty fireclay brick for which GREFCO is famous, provide the best of service in hearth, bosh and stack. Other GREFCO high duty fireclay brick are used in lining piping and other auxiliaries.

Most hot blast stoves are lined with dense, high duty fireclay brick but, for extra severe service, the combustion zone inner lining, the dome, and the top checkers, are built with HIAC or SUPERAC, super duty fireclay brick.

GREFCO's exclusive unburned RITEX basic brick and STEELKLAD, a basic brick permanently jacketed in a patented steel shell, give unmatched service in the open hearth.

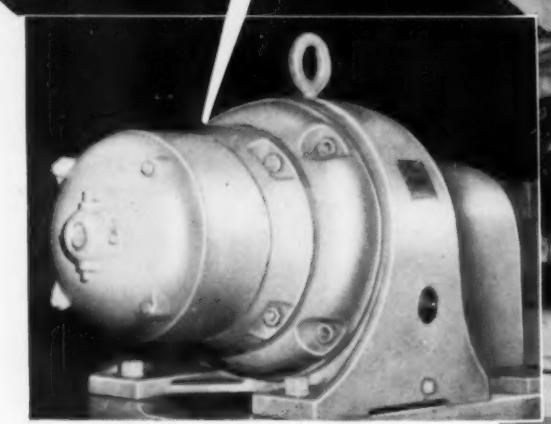
In every other phase of steel production, GREFCO products will be found. There would be no S.S. United States without steel . . . and there would be no steel without refractory brick. If, in your production, you demand quality refractories backed by the most modern of research facilities . . . available in whatever quantity you may require . . . call on GREFCO for a truly *complete refractories service.*

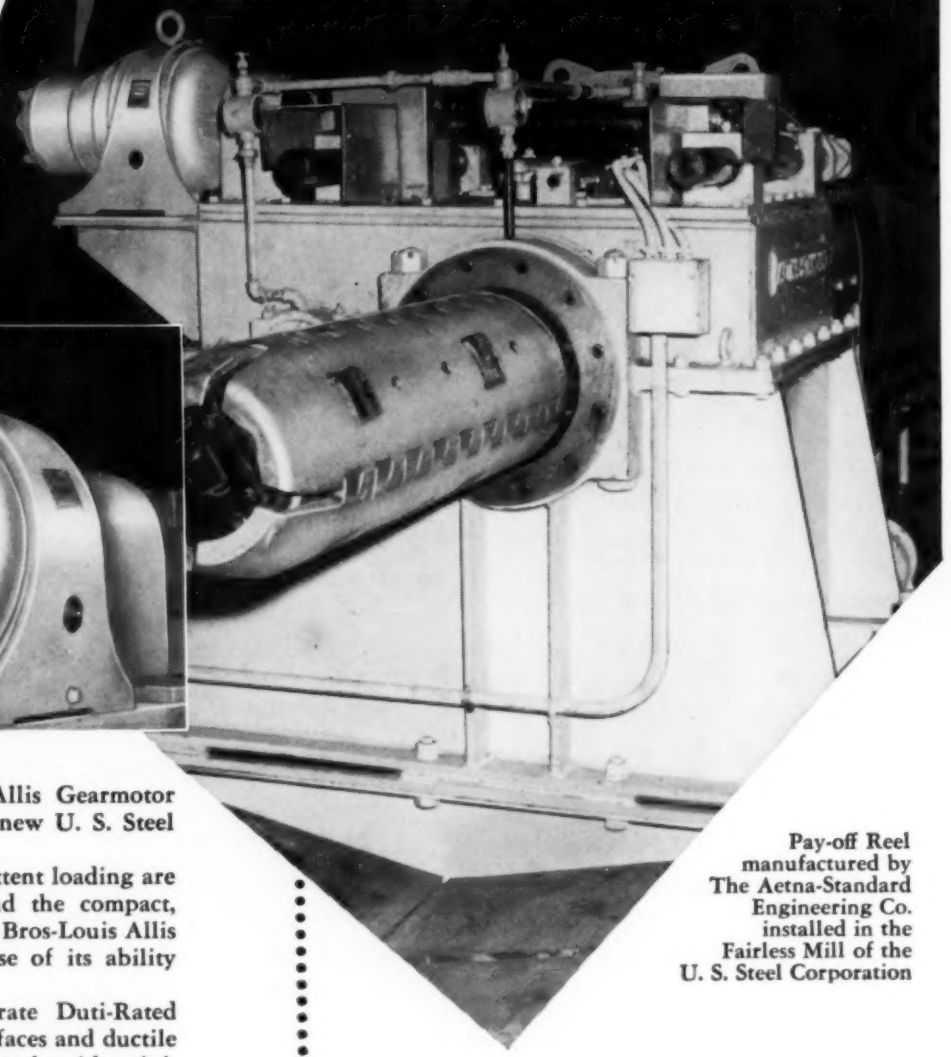
GENERAL REFRACTORIES COMPANY

PHILADELPHIA

GENERAL REFRACTORIES

when a job takes guts here's the gearmotor that has it . . . .





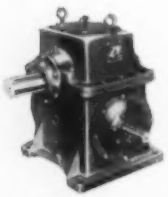
Pay-off Reel manufactured by The Aetna-Standard Engineering Co. installed in the Fairless Mill of the U. S. Steel Corporation

Here's a Foote Bros.-Louis Allis Gearmotor Driving a pay-off reel at the new U. S. Steel Fairless mill.

Rugged service and intermittent loading are characteristics of this job and the compact, low-cost, highly-efficient Foote Bros-Louis Allis Gearmotor was chosen because of its ability to render that service.

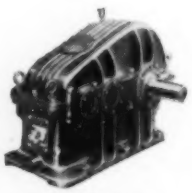
These gearmotors incorporate Duti-Rated Gears, with file-hard tooth surfaces and ductile cores, assuring maximum strength with minimum size and weight. Available in single, double and triple reductions, to provide output speeds of 780 down to 7.5 r.p.m.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard • Chicago 9, Illinois



Hygrade Drives

Line-O-Power Drives



Maxi-Power Drives

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
Dept. IAS, 4545 S. Western Boulevard, Chicago 9, Illinois

Please send me Bulletin GMA containing full information on Foote Bros.-Louis Allis Gearmotors.

Name.....

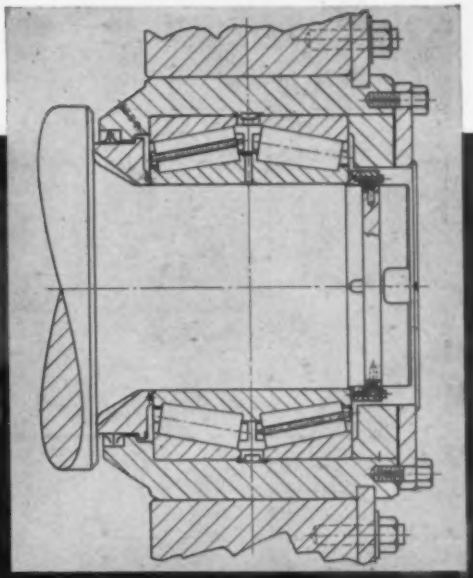
Company.....

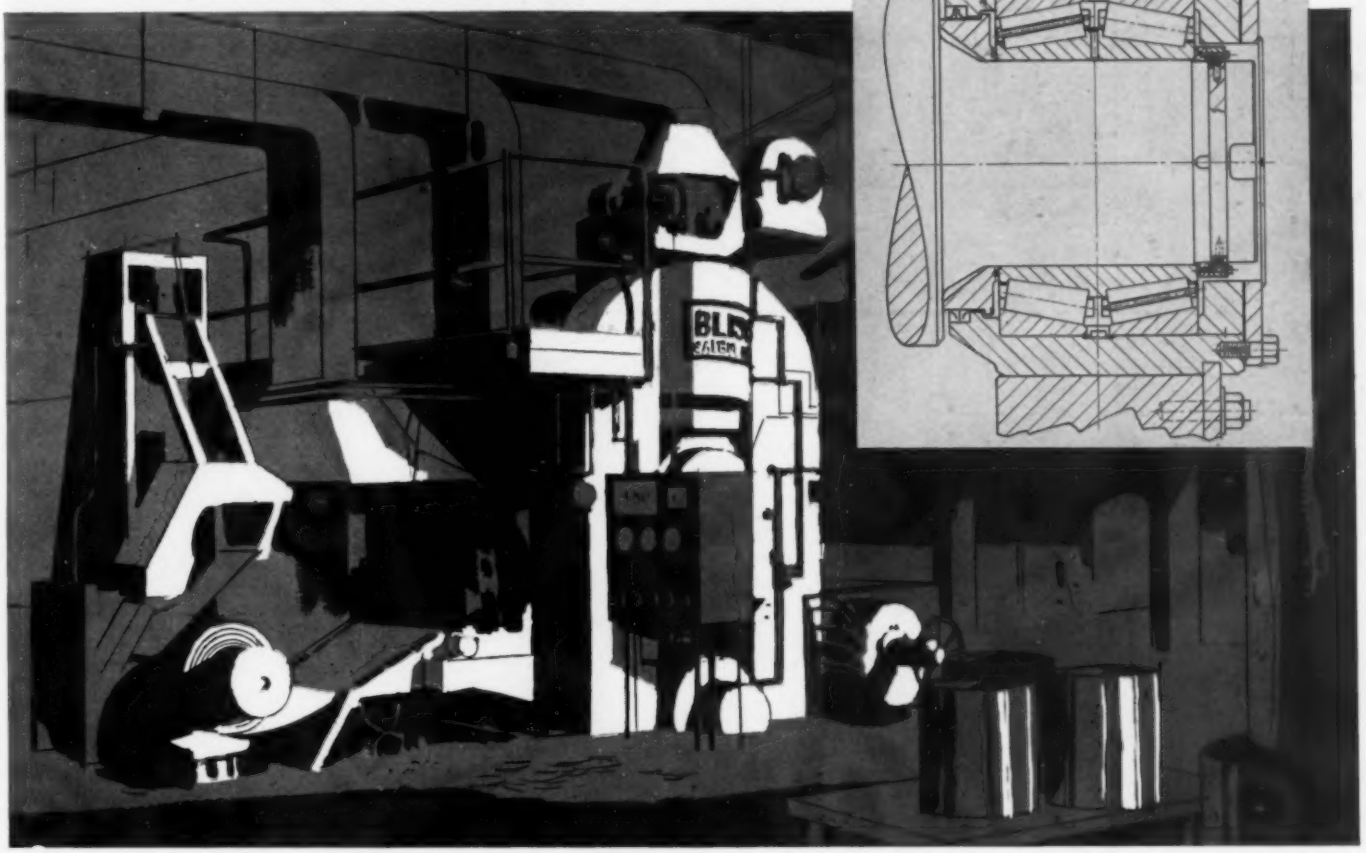
Address.....

Position.....

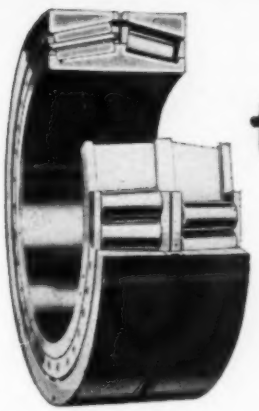
City.....Zone.....State.....

TORRINGTON two-row Tapered Roller Bearings and Spherical Roller Bearings were specified respectively for the back-up and work rolls of the custom-designed Bliss 4-high mill furnished to Aluminio Industrial Mexicano, S.A. This is the first mill of its kind designed and built specifically for service in Mexico.





Rolling higher tonnage records!



TORRINGTON two-row Tapered Roller Bearings are speeding production on many of today's toughest back-up roll applications.

Made from the finest of bearing-quality, case hardening steels, they handle maximum radial and thrust loads with ease. Precision ground, the quality of their surface finishes is uniformly high. And they are available with either pin-type or cast-bronze, land-riding cages.

These advantages, plus controlled lubrication, mean free-rolling service, long life and minimum maintenance attention under virtually any operating conditions.

TORRINGTON two-row Tapered Roller Bearings—like the four-row Tapered Roller Bearings and Spherical Roller Bearings—offer one of the surest, most economical ways to roll higher tonnage records *consistently*.

And tonnage records are the test of any roll-neck bearing. So next time specify TORRINGTON!

THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.

TORRINGTON BEARINGS

Spherical Roller • Needle • Tapered Roller • Straight Roller • Ball • Needle Rollers

THE QUALITY OF SERVICE RENDERED BY...

...LEWIS ROLLS is recognized

by all practical rolling mill men

SUPERIOR "X" ROLLS
AJAX DUPLEX ROLLS
LEWIS "X" AND "XA" ROLLS
SPECIAL PROCESS ROLLS
CLIMAX AND AJAX ROLLS
PLAIN CHILLED IRON ROLLS
SPECIAL TUBE MILL ROLL
ATLAS, ATLAS "B" AND ATLAS "X" ROLLS
MOLYBDENUM CHILLED IRON ROLLS

MANUFACTURERS OF ROLLS AND ROLLING MILL EQUIPMENT FOR THE IRON, STEEL AND NON-FERROUS INDUSTRIES

may we have the opportunity of studying your requirements and submitting our recommendations

ROLLS DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

Industry News...

U. S. STEEL INSTALLS ELECTRONICALLY-OPERATED CONTOUR ROLL LATHE AT HOMESTEAD

▲ Fully automatic contour duplication is an accomplished fact on a 60-in. roll-turning lathe U. S. Steel Corp. recently installed in its Homestead, Pa., roll shop. All-electronic duplicating equipment is used to control the tool's cutting action.

This lathe is used to generate on huge steel mill rolls the complex body outlines which produce beams, channels, ship sections and other rolled steel products. Deep and narrow grooves, such as a closed flange, necessarily must be cut using tools specially adapted to this work.

A major advantage of the lathe is the extreme flexibility of its control system and the ease of maintaining the electronic duplicating equipment. Push-button manual control of all motor-driven tool feeds permits fast roughing of individual passes, and rapid automatic roll finishing.

The duplicating device guides the motion of the cutting tool from a flat template whose contours are exactly those of the roll to be machined in the lathe. A minutely varying degree of angular deflection in a floating tracer stylus moving along the edge of a template is signalled to a control panel.

These signals are electronically amplified, interpreted and fed to two electric motors. The motors' combined action in response to the signals keeps the stylus traveling and hugging the template. Since the cutting tool is mounted on the same movable part of the lathe carriage as the stylus, tool travel duplicates the path of the stylus. Tool deflection presents no problem when taking heavy rough cuts. Compensation can be made for tool deflection during lighter, finishing cuts.

Once a job is set up, the lathe operates with a minimum of operator supervision, duplicating on the roll the contours of the guiding template. Heretofore, roll turning has always been a slow, tedious process involving many hours of roughing and finishing time on each roll.

Mackintosh-Hemphill Co., designer and builder of the lathe, expects it to effect substantial savings in time and money, machining accurately and quickly, complex steel mill rolls. Theory is working out in practice, although the new machine has been in operation only a short time. At the Homestead roll shop, on one type of roll used to produce structural shapes, the lathe cuts estimated roughing and finishing time from 156 to 49 hours; on another from 196 to 49 hours. Rate of metal removal, discounting setup time, ranges from 2 to 1, to 6 to 1, contour lathe vs standard lathe. This naturally depends upon the roll material, which may be cast iron, carbon steel or alloy steel.

Using tungsten carbide tools, the unit turns at headstock spindle speeds up to 32 revolutions per minute. A standard roll turning lathe, working with high speed tools under comparable conditions on the same roll material, would be able to remove metal at spindle speeds between 1 and 4 revolutions per minute.

Present roll shop practice on the new Mackintosh lathe calls for surface speeds of about 60 fpm on iron and 200 fpm on steel.

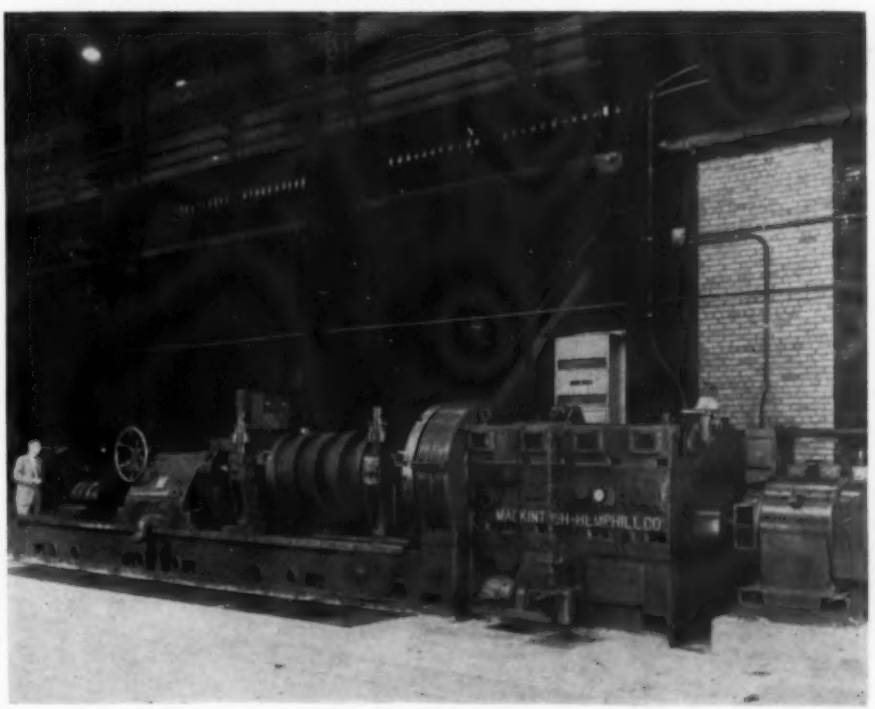
Additional time and labor are saved by a continuous chip disposal conveyor which discharges into easily removable buckets in pits at the end of the lathe bed.

Machining rolls, which may weigh up to 35 tons, can present difficult mounting problems. Some of these are solved by mounting the roll solidly in roll housings. The Mackintosh lathe is the first unit of its size capable of contouring rolls while they are supported on their necks—as in the mill—in the special roll housings, rather than turning on centers. Mounted on the lathe bed, the heavy, completely adjustable housings duplicate actual rolling mill conditions and give stability to the rolls being machined.

The lathe can accommodate rolls up to 54 in. in diameter and 20 ft long. Neck diameters from 11 in. to 28 in. can be handled in the roll housings.

For impressive dimensions, the

Over-all view of 45-ft long lathe set up for turning a cast steel shape roll. Lathe foundation includes mechanized chip disposal system. Lathe main motor drive shown at far right is a 75 hp unit.



With C&D *Slyver-Clad** Batteries
it's all work and no play

COMPARE THEM! At left: an ordinary battery with large, unproductive sediment space and integrally molded supporting ribs. At right: a C & D Slyver-Clad showing longer, power-producing plates. Separate rib plate in new double bottom design distributes battery weight evenly over jar base. Negative plates rest on separate center rib.

With C&D Five-Fold *Slyver-Clad* Batteries you get full shift operation with your Electric Trucks. Their added capacity provides ample power for a heavy duty cycle under all power consuming requirements. And the high capacity and sustained voltage characteristics provide maximum desirable truck speeds for the duty cycle.

This added capacity is made possible by C&D's Five-Fold *Slyver-Clad* method of insulation and retention. The active material is held in place on the positive grid, and sedimentation is virtually eliminated. Normal battery sediment space is reduced, permitting longer and heavier plates, giving from 10 to 30% more capacity in the same size tray.

As Five-Fold *Slyver-Clad* construction virtually eliminates "shedding", C&D Batteries maintain their capacity longer than conventional batteries, with a minimum of 80% of capacity at the fag end of a long life.

*Trade Mark Registered

C&D

BATTERIES, INC.

OF CONSHOHOCKEN, PA.

(In the Philadelphia Area)

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES FROM COAST TO COAST

lathe itself has few peers. Overall length is 45 ft and bed width is 65 in. Face plate is 5 ft in diameter; headstock length 9 ft; carriage length on the bed is 6 ft. Main motor is a 75 hp unit.

But size, rugged construction, speed are not the whole story of this contouring machine. Regardless of its large dimensions, the lathe is still a precision machine.

Maintenance of extremely close tolerances on steel mill roll passes can mean longer life for the rolls and consequently less down time for the mills themselves. Rolling mill experts agree that the closer a roll can be turned to specified tolerance limit, the longer it can be operated between redressings and the better the product it will roll. The fewer the dressings during the roll's life, the more actual time it will see service on the mill.

Mackintosh-Hemphill engineers point out that fast remachining can also mean sizable roll savings because the rolls are out of the roll shop faster and back on the mills. More of their over-all life is spent profitably on the production line, not in the roll shop.

BRAKE SHOE EXPANDS NEW YORK STATE PLANT

▲ American Brake Shoe Co. is expanding its facilities for the manufacture of powder metallurgy products. As part of its diversification program, the company entered the field after four years of laboratory research. The first products to be marketed were friction materials for clutch parts. Applications are in progress in the research laboratories and in field tests.

Production facilities were installed in the company's Hillburn, N. Y., plant and the expansion will double present capacity. The plant is operated as a unit of the American Brakeblok Division which manufactures automotive and industrial brake lining and laminated plastic bearing materials.

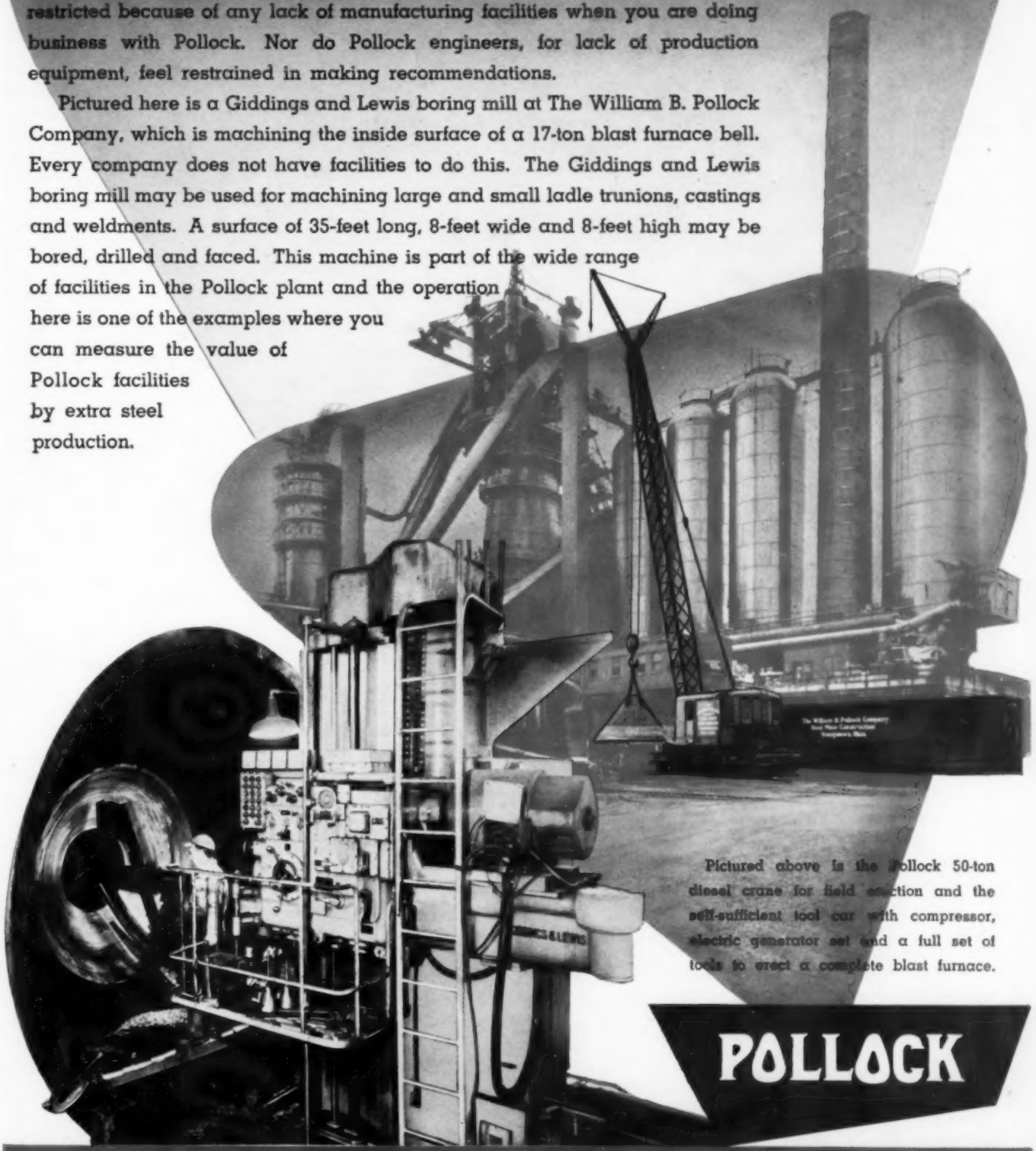
NACA VALVE CONTRACT AWARDED SALEM-BROSIUS

▲ Salem-Brosius, Inc., Pittsburgh, Pa., has received from the National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio, a contract

POLLOCK facilities encourage higher specification standards in steel construction

Your progressive ideas for blast furnaces and steel plants are not restricted because of any lack of manufacturing facilities when you are doing business with Pollock. Nor do Pollock engineers, for lack of production equipment, feel restrained in making recommendations.

Pictured here is a Giddings and Lewis boring mill at The William B. Pollock Company, which is machining the inside surface of a 17-ton blast furnace bell. Every company does not have facilities to do this. The Giddings and Lewis boring mill may be used for machining large and small ladle trunions, castings and weldments. A surface of 35-feet long, 8-feet wide and 8-feet high may be bored, drilled and faced. This machine is part of the wide range of facilities in the Pollock plant and the operation here is one of the examples where you can measure the value of Pollock facilities by extra steel production.



Pictured above is the Pollock 50-ton diesel crane for field erection and the self-sufficient tool car with compressor, electric generator set and a full set of tools to erect a complete blast furnace.

POLLOCK

THE WILLIAM B. POLLOCK COMPANY • YOUNGSTOWN, OHIO

STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

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RED CIRCLE Rolls ALLOY-CHILLED

Red Circle Rolls for all Purposes

Hyde Park Red Circle Rolls are outstanding in quality and in performance and are easily identified by the Red Circle.

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finer finish
long life
greater tonnage
Specify Red Circle

Chilled Rolls
Alloy Iron Rolls
Moly Rolls
Nickel Chilled Rolls
Grain Rolls
Cold Rolls
Sand Rolls

Hyde Park

FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

for the design and construction of two 15 ft diameter butterfly valves for use in aircraft propulsion research.

These valves, probably the largest of their kind ever to be required, are being especially designed by Salem-Brosius, Inc. in cooperation with the engineers of the NACA Labs, Cleveland.

KOPPERS DEDICATES FONTANA TAR PLANT

▲ Koppers Co., Inc., informally dedicated its new plant at Fontana, Calif., on February 5 with a plant tour and luncheon attended by more than 400 industry, business and civic leaders of the Fontana and Los Angeles areas.

Operated by Koppers Tar Products Division, the new plant is now producing a general line of products made from the crude tar which comes from Kaiser Steel Corp.'s chemical-recovery coke ovens. These are being made available to west-coast markets.

CANADIAN FACILITIES EXPANDED BY FOXBORO

▲ A new plant extension by Foxboro Co., Ltd., at Montreal, Canada, has more than doubled its instrument manufacturing facilities in Canada, according to an announcement by Foxboro Co., Foxboro, Mass. The recent expansion, second in the past five years, reflects the ever-growing demand for indicating, recording and controlling instruments by Canadian industry.

Matching the original building in arrangement and appearance, the new section is of modern steel and brick construction, with spacious window area and sawtooth skylights. It adds 23,000 sq ft of factory space for the production of instrument parts, assembly of instrument panels and cabinets, storage of materials, and for enlargement of the plating, finishing and shipping departments. An additional 5000 sq ft on a lower level provides a new cafeteria for employees and training school facilities for customers' men, who are instructed in the proper use and maintenance of instruments.

Designed to meet future as well as immediate needs, the plant extension includes under-floor service ducts to eliminate overhead piping of air, water, gas and electricity; an underground switchroom and transformer station, and foundations for still another building.

ASA ANNOUNCES NEWLY APPROVED STANDARDS

▲ The American Standards Association, Inc., approved 87 standards in 1952. The increase brought the total American Standards in effect to 1264.

Company members of ASA now number 2337. Trade associations, technical societies and consumer organizations enrolled in ASA number 114.

Newly-approved standards of particular interest to the machinery industry included: Physical Specimens of Surface Roughness and Lay, B46.2; Square Hexagon Bolts and Nuts, B18.2-1952; Accuracy of Engine and Tool Room Lathes, B5.16-1952; Specifications for Carbon- and Alloy-Steel Nuts for Bolts for High Pressure and High-Temperature Service, G38.1-1952; Mounting Dimensions of Lubricating and Coolant Pumps for Machine Tools, B5.28-1952; and Preferred Thicknesses for Uncoated Thin Flat Metals (Under 0.250 In.), B32.1-1952.

AIRCO BEGINS OXYGEN DELIVERY AT BUTLER

▲ The recently completed Air Reduction Sales Co. liquid oxygen plant in Butler, Pa. has commenced delivery of oxygen to industrial customers. The plant supplies oxygen directly by pipeline to two Butler customers, Armco Steel Corp. and Pullman Standard Co. In both cases these companies use oxygen in the processing of steel.

The plant, which operates continuously, has a rated capacity of 100 tons of liquid oxygen per day making it Air Reduction's largest liquid oxygen installation.

Conventionally, oxygen is delivered in gaseous form by steel cylinders, tube trailers or pipelines. Liquid oxygen permits an expansion of delivery distances and offers additional economy and convenience in transportation and storage. The oxygen is generally converted to gaseous form for use. The Butler plant will also produce argon and nitrogen.

NOW—

Keystone ALUMINUM Conductor System for all Applications

A NEW, COMPLETE SYSTEM OFFERING HIGH CURRENT CAPACITY AND LOW IMPEDANCE

Keystone introduces a new development—an aluminum conductor (third rail) system. In addition to conserving critical copper and steel, it offers industrial users many important operating and structural advantages. Here is a complete sliding contact system which is pre-engineered, efficient and compact in design, yet constructed for years of service. It has high current-carrying capacity . . . up to 1,000 amperes . . . with a small cross-sectional area.

Non-magnetic, the new Keystone Aluminum third rail system provides good voltage regulation for alternating current because of its low impedance. It offers new economies because it is easier to install, requires less manpower and eliminates the need for high-cost supporting structures.

It is designed for such applications as main crane runways, bridge conductors, hydro-electric dams and numerous other jobs.

If you have a collector problem or plan a new installation replacement of an old system, consult our engineering specialists.

OPERATIONAL FEATURES

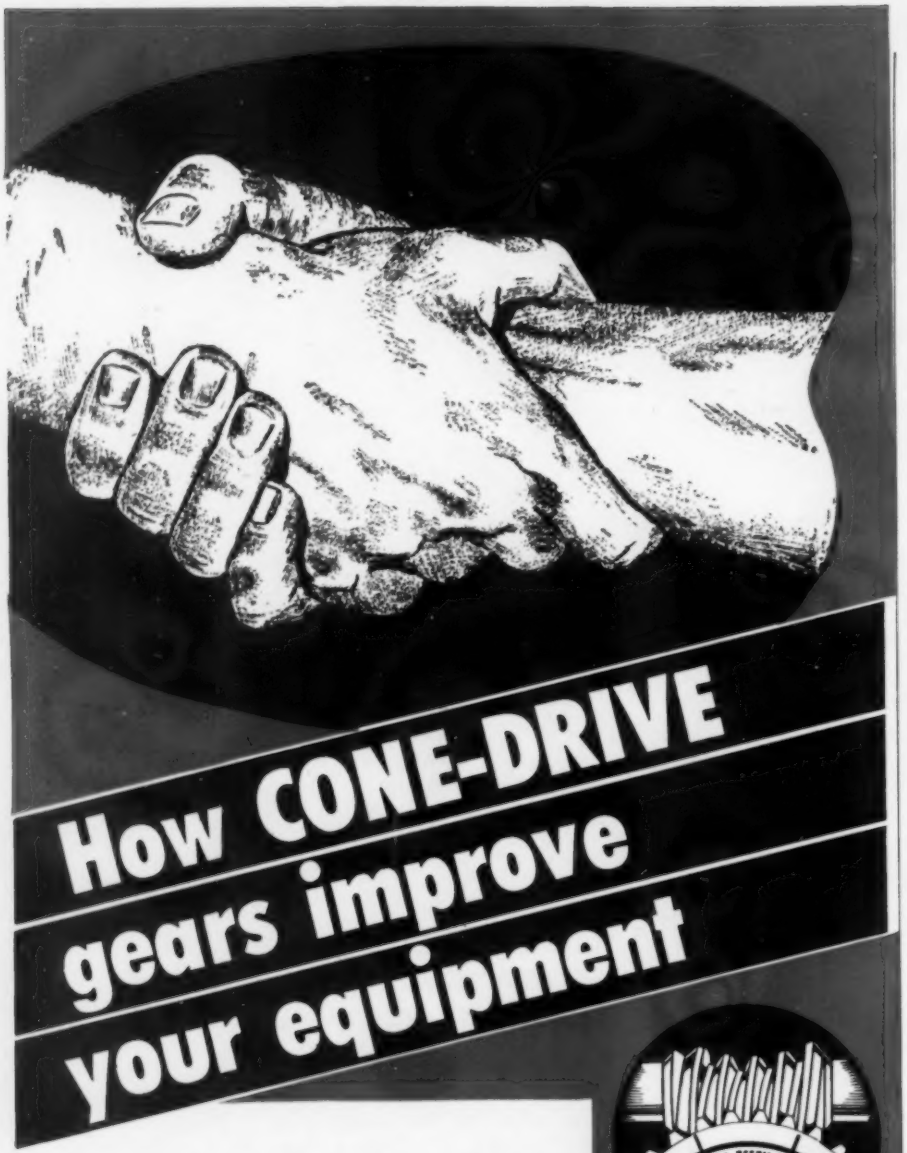
- Requires less space
- Operates under conditions unfavorable to other metals
- Easy maintenance
- Pre-engineered components for easy assembly.

Write today for new, illustrated 4-page folder on Keystone Aluminum Conductor System.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

Represented in Canada by Lyman Tube and Bearing, Ltd., Montreal and Toronto



How CONE-DRIVE gears improve your equipment

You can be sure, if the equipment you purchased is operated through Cone-Drive gears or speed reducers, that the manufacturer is giving you "the best."

The secret of Cone-Drive gears and speed reducers is their double enveloping action. Double enveloping—the worm wrapped around the gear, the gear wrapped around the worm—means far greater load capacity for a given gear size, amazing smoothness, greater shock load capacity, far longer life expectancy and trouble-free operation.

Ask if the equipment you buy has double enveloping Cone-Drive gears or speed reducers if you, too, want "the best at the lowest cost."

Standard double-enveloping Cone-Drive gearsets and reducers have greater contact per tooth, more teeth in contact, increased load capacity, greater shock load capacity, longer life, lighter weight—and lower overall cost.

For information on use of Cone-Drive gears and reducers in your field, ask for Bulletin No. 789-S0.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

EUROPEAN AFFILIATE ANNOUNCED BY LOFTUS

▲ Loftus Engineering Corp., Pittsburgh, Pa., has announced the formation of its affiliated company, Loftus International S. p. A. with offices at Via Durini 27, Milano, Italy, to serve the iron and steel industry of Europe.

Loftus International offers its experience to the Italian steel and nonferrous industries in the following fields: Consultation on metallurgical processes relative to the treatment of raw materials, to the steel production, to the rolling and finishing problems and practices. Study of projects for new facilities and improvement of existing ones to justify their technical and economic practicability. Design and construction of complete plants and departments thereof, open hearths, soaking pits, rolling mill heating furnaces, forging annealing and normalizing furnaces for all types of heat treatment and processing with various types of fuel as well as induction heating furnaces. Modification and improvement of existing furnaces with particular consideration given to the metallurgical nature of the work to be performed.

WESTERN PLANT TO MAKE BASIC REFRACTORIES

▲ The Warm Springs, Calif. plant of Harbison-Walker Refractories Co. now has been completely converted to the production of chemically bonded basic refractories. The plant, which was acquired by Harbison-Walker early in 1952, formerly was a producer of the alumina-silica classes of refractories.

Converting the Warm Springs works to the production of basic refractories, the purpose for which the plant was purchased, enables Harbison-Walker to better serve the basic refractory requirements of many of the industries now locating in the growing industrial area of the west.

BLAST FURNACE NO. 1 RESUMES AT DUQUESNE

▲ With resumption of operations at No. 1 blast furnace on February 6, U. S. Steel Corp.'s Duquesne, Pa., works will have its full complement

LOW COST PRODUCTION WITH

Wide Strip Annealing Furnaces

Increased tonnage with production economy . . . that's the actual experience reported by a leading steel company, operating Drever continuous annealing lines for 42-inch coiled silicon steel strip, pictured above.

Users report consistent, uniform anneal and excellent surface characteristics; resulting in increased stamping die life.

Cleaning is incorporated in the line, thus eliminating a separate operation.

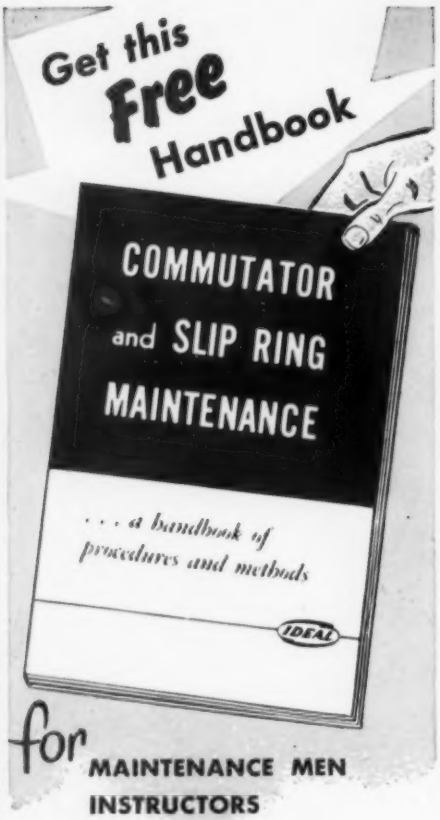
Both quality and low cost production are designed, engineered and built into Drever Wide Strip Annealing Furnaces.

Complete annealing lines for Low Carbon, Tin Plate and Galvanizing stock; also Non-Ferrous strip. Capacities up to, or even exceeding 60,000 lbs. per hour.

View of two 20,000 lb. per hour DREVER CONTINUOUS ANNEALING LINES for 42" wide STEEL STRIP. Delivery end, showing 1820 K. W. Vertical Strip Furnaces and strip recoiling equipment.

P.S.
Our many years of experience is available to you, without obligation, in discussing your particular requirements.

DREVER CO.
720 E. VENANGO ST., PHILA. 34, PENNA.
CONTINUOUS FURNACE LINES, HEAT TREATING FURNACES, DESCALING & ATMOSPHERE EQUIPMENT
W. PENNA.: H. Y. AND OHIO H. C. BOSTWICK, 1940 S. MORELAND BLVD., CLEVELAND, 22, OHIO



for **MAINTENANCE MEN**
INSTRUCTORS
and TRAINEES
in Motor Maintenance

THE methods and procedures described were developed by recognized, practicing maintenance authorities. They have been proven by conclusive evidence over many years in hundreds of operations. A concise guide, this 39-page handbook tells the practical operating man everything he needs to know about:

- **Commutator and slip ring troubles and how to correct them.**
- **Brush maintenance and operating procedure.**
- **General maintenance procedure.**

Dozens of illustrations show the operations described. Condensed data on IDEAL commutator and slip ring products is included.
Even if you do not have a regular maintenance training program, your people responsible for motor and generator maintenance need, and will do a better job, with the help of this handbook.

NOTE: This offer is limited to those in plant and other industrial operations. We reserve right to limit quantities furnished. Offer may be withdrawn at any time.

IDEAL INDUSTRIES, Inc. IDEAL
1045 Park Avenue, Sycamore, Illinois

Please send _____ copies of your free handbook on commutator and slip ring maintenance.

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____

NEW GUNS PRODUCED AT AETNA-STANDARD

Skysweeper, a 75 mm artillery machine gun, developed by Army Ordnance, is the largest caliber automatic gun in the Army's aresenal of weapons, and the newest and most effective defense against low flying, high speed enemy aircraft. Radar and computer are mounted integrally with the gun, making the skysweeper virtually a three-in-one unit which can spot, track, and intercept invading planes. These skysweepers are shown at the plant of Aetna-Standard Engineering Co., Ellwood City, Pa.

of six blast furnaces in operation. This furnace had been taken out of operation on December 15, last year, for a complete relining. This included the hearth, bosh and stack.

In carrying out this project, the hearth diameter was increased from 19 ft to 20 ft and other necessary alterations were made. The iron making capacity for the U. S. steel furnace was also increased from 635 tons a day to 704 tons of iron daily.

The last "campaign" for No. 1 blast furnace ran 2,132 days during which time 1,402,643 net tons of iron were made.

JERSEY FIRMS JOIN TO MARKET FILTERS

▲ Sintering Machinery Corp., Netcong, N. J., and Equipment Development Co., Inc., Montclair, N. J., have announced that an agreement has been concluded between the two companies for the development, manufacture and sale of a complete line of filtration equipment to be marketed under the trade name of "Edco-Sintering."

Under the agreement, Sintering Machinery Corp. will manufacture and stock filtration units and parts, making available its extensive fabrication and machinery facilities at its Netcong, N. J. plant. Equipment Development Co., Inc., operating under its numerous patents, will design, engineer and sell the "Edco-Sintering" line. Complete development and testing laboratories will be maintained.

KOPPERS WILL BUILD COKE OVENS AT WEIRTON

▲ Weirton Steel Co., division of National Steel Corp., has awarded Koppers Co., Inc., a contract to design and construct a battery of 41 chemical-recovery coke ovens at its Weirton, W. Va., plant.

Included in the contract for the new battery of Koppers-Becker underjet coke ovens is a belt conveyor system to deliver coke from the metallurgical coke screening station to railroad cars on the blast furnace high line.

Where Quality Counts Most . . . Count on

NATIONAL CARBON BRUSHES

TRADE-MARK

FOR MAIN-DRIVE MOTORS AND GENERATORS

Quality *counts* most where failure *costs* most . . . in the main drives and generators upon whose sustained efficiency uninterrupted production depends.

Chances are you're already *paying* for the best brushes in these and other vital applications; make sure you *get* the best by specifying "National" brushes.

For toe-to-toe and tandem-type holders, there are "National" STANDARDIZED brushes to meet your requirements . . . delivering not only the uniform high quality and dependability of *all* "National" brushes, but the added conveniences of uniform packaging, delivery from stock and the big economy of a *flat unit price!*

HERE'S WHY "NATIONAL" BRUSHES ARE BETTER:

- Service proved dependability
- Closely controlled commutation factor
- Minimum commutator wear
- Long life
- Uniformity from shipment to shipment

NATIONAL STANDARDIZED BRUSHES

BETTER— PRODUCT—PACKAGE—PRICE— FASTER

The term "National", the Three Pyramids device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

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A Division of Union Carbide and Carbon Corporation
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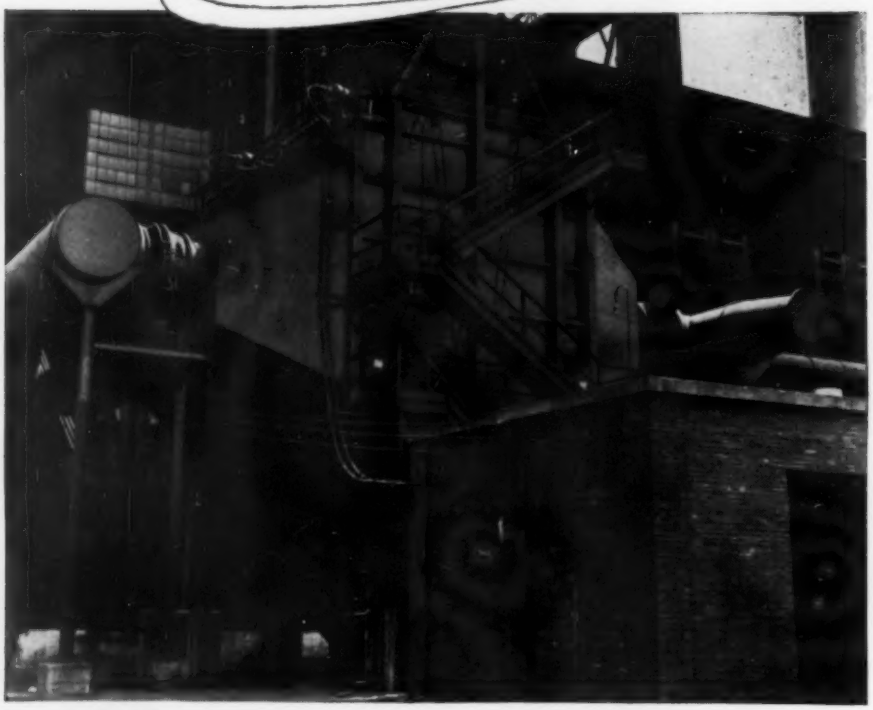
Use them every day

. . . or only once a year



Bailey ENGINEERS

MECHANICAL

GOGGLE VALVES

Stay Dependable

60" x 48" Bailey Valve.

Totally enclosed 6" Valve.

Regardless of the length of time between operations, these valves operate instantly to provide a tight seal for shutting off gas mains. They require a minimum of maintenance and operate by a powerful clamping force applied equally at all points around disc periphery. Sizes from 6" to 72", totally enclosed if desired.

WILLIAM M. Bailey COMPANY

ENGINEERS

LEADERSHIP THROUGH QUALITY

1221 BANKSVILLE ROAD PITTSBURGH 16, PA.

These new ovens will increase the coal carbonizing capacity of the plant by 1,000 tons of coal per day.

PLAN ROLLING MILL FOR ALUMINUM ALLOY PLATES

▲ Hydropress, Inc., New York, is designing and building a new type rolling mill for the fabrication of tapered aluminum alloy plates and sheets. Such items are required for the latest model military and naval aircraft.

The 145 in. four-high rolling mill will be the largest installation of its kind in the world. It will permit the hot or cold rolling of aluminum alloy sheets and plates from 0.032 in. to 3.0 in. thickness. Operation is scheduled for late 1953.

NEW FACILITIES SECURED BY GOLDEN-ANDERSON

▲ Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., has acquired the shop and equipment of Imperial Machine Works, Inc. The increased production facilities of this new addition, which contains over 20,000 sq ft of usable floor space, were needed to take care of the heavy demand for Golden-Anderson products.

HYDROPRESS TO BUILD GIANT INTEGRATED PRESS

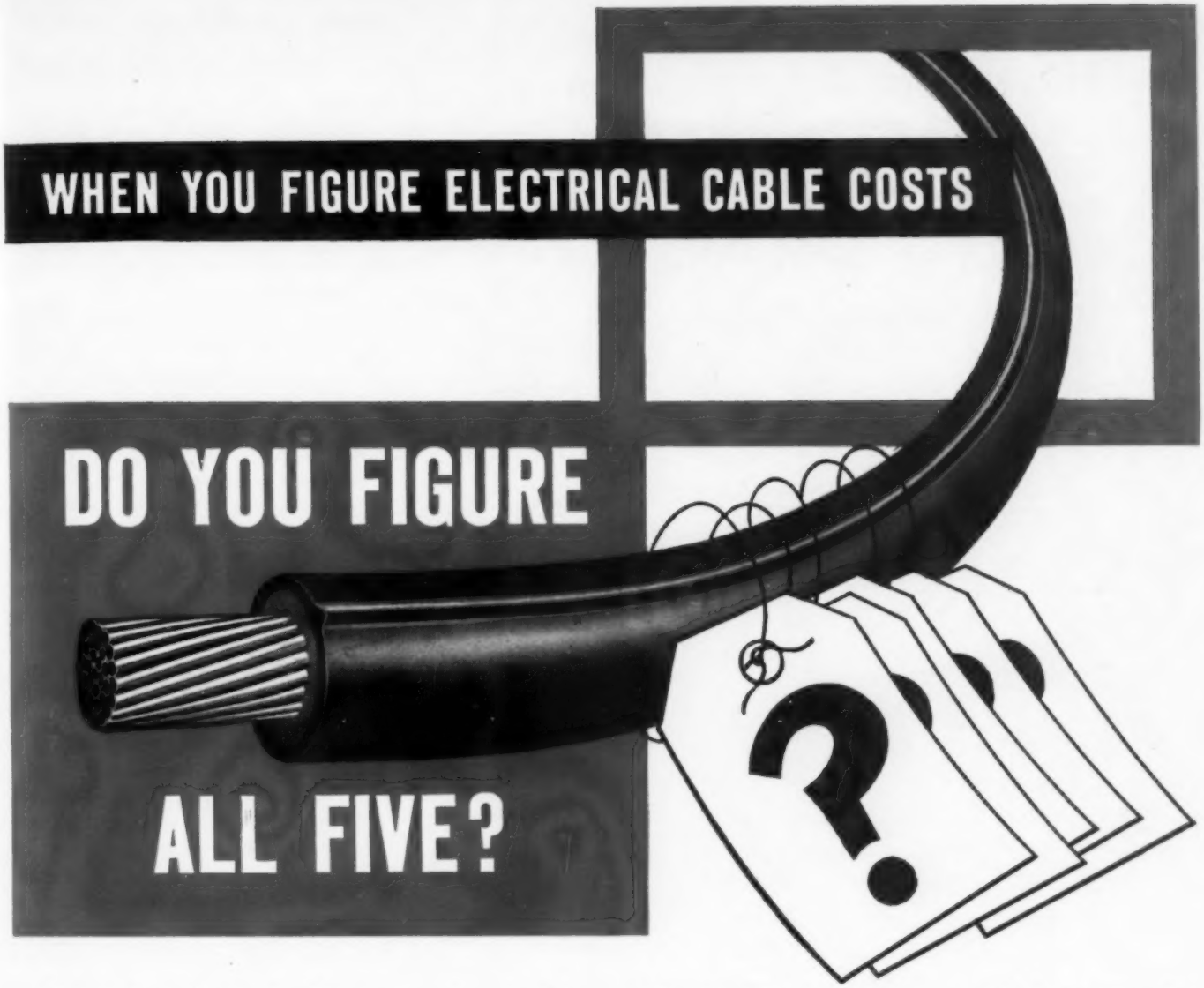
▲ The Glenn L. Martin Co. of Baltimore has ordered from Hydropress, Inc., New York, N. Y., a new type Marform press with a capacity of 6500 tons.

This is the largest integrated precision deep drawing unit in operation up to now. The new feature is a considerably simplified tooling arrangement which permits also the use of the unit for Guerin and other deep drawing processes.

FRENCH FIRM APPOINTED FEMCO EUROPEAN AGENT

▲ Farmers Engineering and Manufacturing Co. of Irwin, Pa., has announced the appointment of the firm of Reno-Lepaute of Paris, France, as licensed manufacturers and sales agents for Femco electronic communications in continental Europe and French possessions overseas.

WHEN YOU FIGURE ELECTRICAL CABLE COSTS



All too often electrical cables are purchased solely on the basis of initial cost. Actually, of course, this is only one of five factors to consider . . . and no true cost comparison can be made until the four "hidden" costs are figured.

Here are the four "hidden" costs which often upset your overall budget, particularly when you're trying to "economize":

- **installation costs**
- **maintenance costs**
- **costs of power shutdowns when a cable fails**
- **costs of replacing a cable which has failed prematurely.**

Okonite cables are the most effective means for combating these costs. A wide range of Okonite cable designs assures you of the most economical installation for any type of operating condition. And for savings throughout the life of the cable, Okonite always uses the premium materials and exclusive processing techniques which deliver unfailing electrical service year in and year out.

We can't condense millions of man-hours of cable research, field engineering and manufacturing experience into a short description of Okonite cables. But your Okonite representative can show you in black and white why the best cables – Okonite cables – really carry the lowest overall cost. The Okonite Company, Passaic, N. J.

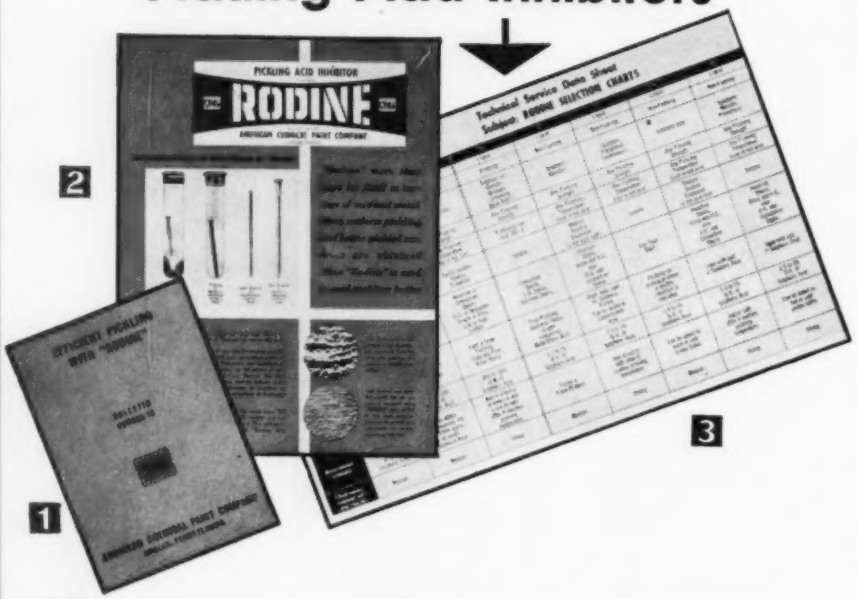
The best cable is your best policy

OKONITE SINCE 1878 *insulated wires and cables*

New Data Available on . . .

RODINE®

Pickling Acid Inhibitors



1 The standard reference work on pickling, "Efficient Pickling With RODINE" — Bulletin Number 13 — is now available in a new, revised edition.

2 This new 4-page general descriptive folder presents essential information on "Rodine" pickling acid inhibitors.

3 The recently revised "RODINE SELECTION CHART" gives characteristics of and uses for typical "Rodines" used with sulfuric and muriatic acids. Technical Service Data Sheet No. 13-1-1-4.

Use coupon below for free copies of the literature described above.

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Please send me FREE:

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- ☐ 4-page general descriptive folder.
- ☐ "RODINE SELECTION CHART"

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City ..... State .....

FIRM INSTITUTES

PLANT TRAINING PLAN

▲ An extensive cost reduction training program, unique in its techniques, approach, and objectives, was recently instituted by John E. Fast & Co., 3123 Pulaski Road, Chicago, Ill. The program is authored by Wheeler Associates, Cleveland consulting engineering firm.

The program which is already reaping amazing benefits for P. R. Mallory & Co., Inc., Indianapolis, Ind., covers a 12-week period. More than 80 Fast executive and operating personnel will "go back to school" under the program. In addition, and for the first time, a select group of present hourly-rate personnel will be given a separate course to indoctrinate them as future supervisors.

The program covers such subjects as "methods improvements," "methods demonstrations," "plant and work area layout," "material handling," "keeping equipment in top condition," "importance of cost reduction," and many others.

Keys to the training program are a variety of informative, highly successful visual aids. These take the form of colorful charts and other demonstration devices; stage money matches, memory jogger pads, bulletin board signs, etc. Each participant in the program receives a comprehensive executive manual containing detailed material on each conference.

In commenting on the cost reduction training program, Louis Kopinski, president, John E. Fast & Co., states: "We sincerely believe that this program of cost reduction will make our people more cost conscious, more conscious of their responsibility toward themselves and their future. We know that it is only when both management and operating personnel work together that we can raise our output, decrease our fixed costs, and offer our customers a better product at less cost."

According to William S. Wheeler, author of the program, and president of Wheeler Associates, "we have seen in other companies how such a program can do the job progressive management wants. We have been thrilled with the sharply declining cost curves which may be definitely traced to hard-hitting management-employee cooperation in making everyone more cost conscious. It is

our earnest belief that progressive American firms, realizing the trend to a buyers' market, which of necessity lies ahead of us, will realize the need for cost reduction training in their plants."

U. S. STEEL PLANS NEW RESEARCH CENTER

▲ An entirely new research center for developing new and better steels and steel technology will be constructed by United States Steel Corp. The center will be located in a rural area of Allegheny County near Pittsburgh, Pa. Initially, the new center will be devoted primarily to applied research and to better co-ordination of the many research projects which already are under way in United States Steel. At present, the corporation has laboratories in Pittsburgh and Kearny, N. J., as well as smaller units in its steel-making plants throughout the country.

The new center will be of great assistance in carrying out U. S. Steel's expanding research program, which is devoted to many studies important to national defense, including increasing production in existing plants.

In the new research center, U. S. Steel's scientists and technologists will be able to carry out more effectively the traditional practice of developing better steels for our customers. At the present time, of course, we are concentrating on requirements of the armed services. But many of the facts we are now learning about the steels needed for defense will make it possible for us to provide improved steels for civilian use.

United States Steel, in common with the steel industry generally, is faced with many important research problems. Some of the more urgent of these are: how to offset the deteriorating quality of available raw materials; how to meet the necessity for conserving scarce strategic metals such as nickel, tin, manganese and columbium; how to develop new or improved steels to meet specific military needs. Research personnel throughout United States Steel, in close cooperation with plant technologists, are constantly striving to solve these and many related problems. And they need the best facilities which can be provided.

THIS PICTURE TELLS A STORY of a new cost-cutting opportunity for steel mills

Note the ready accessibility of each item of steel in this storage yard of a well-known steel mill. It's this availability of materials that's one of the prime advantages of the ROSS STRADDLE CARRIER handling method . . . an advantage, unmatched by any other method, that eliminates delays, lowers costs and increases the production efficiency of the mill.

ROSS STRADDLE CARRIERS, heart of the Ross unit-load handling system, are built to handle 45,000-pound concentrated loads on around-the-clock schedules in the roughest, toughest steel mill service . . . to put those loads *where* wanted *when* wanted.

Your mill, too, can profit by this modern, flexible mass handling system. Get in touch with Ross today for the complete details.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Dealers Throughout the World

400 MILLER ST., BENTON HARBOR, MICH., U.S.A.

OPERATING COSTS REDUCED WITH TM ALLOY STEEL CHAIN!

The growing use of TM Alloy Steel Chain is resulting in lower chain costs everywhere, according to the S.G. Taylor Chain Company of Hammond, Indiana. Special Analysis Alloy Steel and Taylor's unique chain-making methods assure a product that has twice the strength, twice the safety factor and many times the life of wrought iron chain.

These features plus the fact that TM Alloy Steel Chain is heat-treated and never requires annealing... its resistance to shock at all temperatures... its ability to withstand work hardness and grain growth add to the success of this chain. A complete line of slings, in a variety of sizes, with a choice of alloy steel attachments is available from stock. Two types of patented magnet chain assemblies are also available. TM Alloy Steel Chain is manufactured to customer's specifications as well. Contact your distributor today or write Dept. 4, S. G. Taylor Chain Company, Hammond, Indiana.

FOR BEST RESULTS
USE—
TM
ALLOY STEEL
CHAIN
TAYLOR CHAIN
HAMMOND IND.
STRONGER
TM Alloy Steel Chain has twice the strength of wrought iron chain!
SAFER
On a size for size basis TM Alloy Steel Chain has twice the safety factor of wrought iron chain!
LASTS LONGER
This famous chain lasts five to fifteen times longer than wrought iron chain!
COSTS LESS
TM Alloy Steel Chain's greater strength and longer life means lower chain costs for you.

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

S. G. Taylor Chain Co.
Dept. 5
Hammond, Indiana

Rush free catalog on Alloy Steel Chain.

Name_____

Address_____

The proposed center will consist of three buildings with a combined floor area of approximately 132,000 sq ft: a main laboratory building, an experimental engineering shop, and an industrial process development building.

The main laboratory will be two stories high, and will house the physical, chemical, and metallographic apparatus for performing precise, small-scale scientific work. It will also contain a sizable meeting room, offices, and reception area. Design of the exterior will follow modern architectural lines. Present plans contemplate stainless steel for the spandrels between first and second floor windows. The building will be of steel-frame construction, with stone and brick walls.

The experimental engineering shop will be built more along the lines of conventional industrial-type buildings to provide large areas of unobstructed floor space. It will have a steel frame with brick walls. This building will house small pilot-line projects, in addition to providing enclosed areas for carrying out investigations in the chemical and process engineering fields. There also will be adequate enclosures for electric-induction steel-melting furnaces, ceramic-testing furnaces, mechanical testing equipment, and test-welding units. The machine shop, boiler room and storage facilities will occupy the remainder of the building. The main bay of the shop will be 70 ft wide, with a 26-ft wide bay on either side. Two overhead cranes, each of 20 tons capacity, will serve the machine shop and pilot lines in the main bay.

A third unit, the industrial process development building, will follow modern mill-type design. It will be divided into two adjoining sections, in which somewhat larger-scale engineering developments can be set up and studied.

Design of the new research center provides great flexibility for carrying both present and proposed research projects. Provision is made for ample future extensions if they become necessary. The laboratory staff at present consists of approximately 340 persons, of whom 170 are scientists and technologists.

Two sites have been selected for consideration as a possible location for the research center, one near Harmarville and another near Monroeville.

TNEMEC PRIMERS KILL RUST!

THE first step in preserving steel with paint is applying the prime coat. Its primary job is to prevent and kill rust action. TNEMEC Primers do just that, by creating a neutral condition on steel surfaces, changing active rust and corrosive agents into an inactive neutral compound.

The second step is applying the finish coat that will provide protection against the specific exposure hazards involved.

WHAT IS YOUR EXPOSURE HAZARD?

Is it the humid, salt-air atmosphere of coastal areas? Is it the acid-laden atmosphere found in and around industrial plants, refineries, steel mills, the processing industries, etc? Is it submersion in sewage treating vats, in salt brine, or in fresh water tanks?

No matter what your problem is, there is a TNEMEC Finish Coat to solve it. And remember . . . you will always save many maintenance dollars by doing the job *right*.

Ask Any TNEMEC User
(TEE-NEE-MIK)

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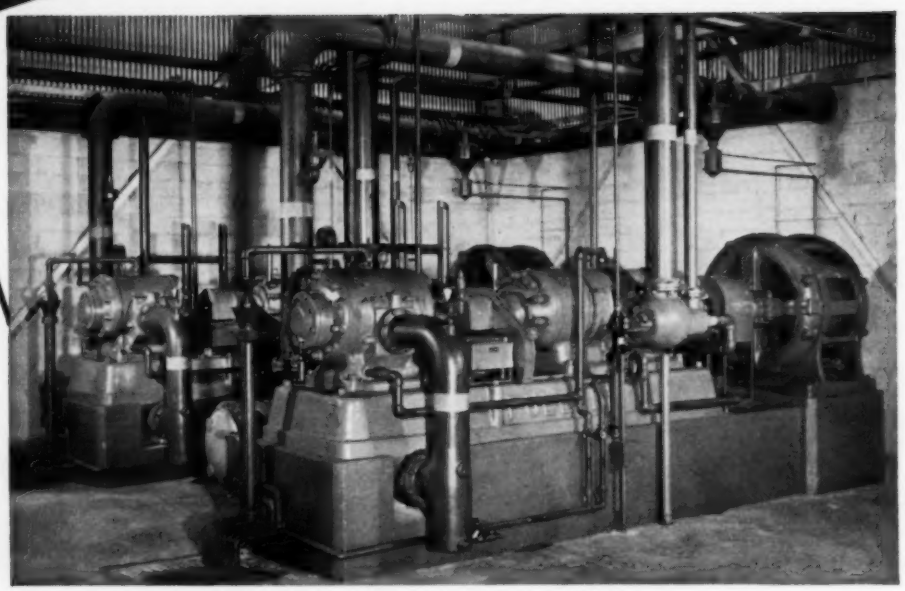
means ECONOMICAL OPERATION

means FULL DEPENDABILITY



FULLER ROTARY COMPRESSORS are engineered and built right to insure a fully dependable source of air power for all steel plant and foundry operations. Moving parts have been kept to the minimum—rotor, bearings and blades—require little attention.

There are no valves to leak, no seats to grind. Blades automatically compensate for wear. Force-feed lubrication to all parts within the cylinder insures constant protection, with minimum wear.

Foundries and steel mills have put Fuller Compressors on the payroll. They've found them to be completely reliable under all conditions of service—and they've found them to be as economical to operate as they are dependable. Why not investigate this modern, efficient compressor the next time you are in the market? Write for Bulletin C-5, illustrating and describing these machines.

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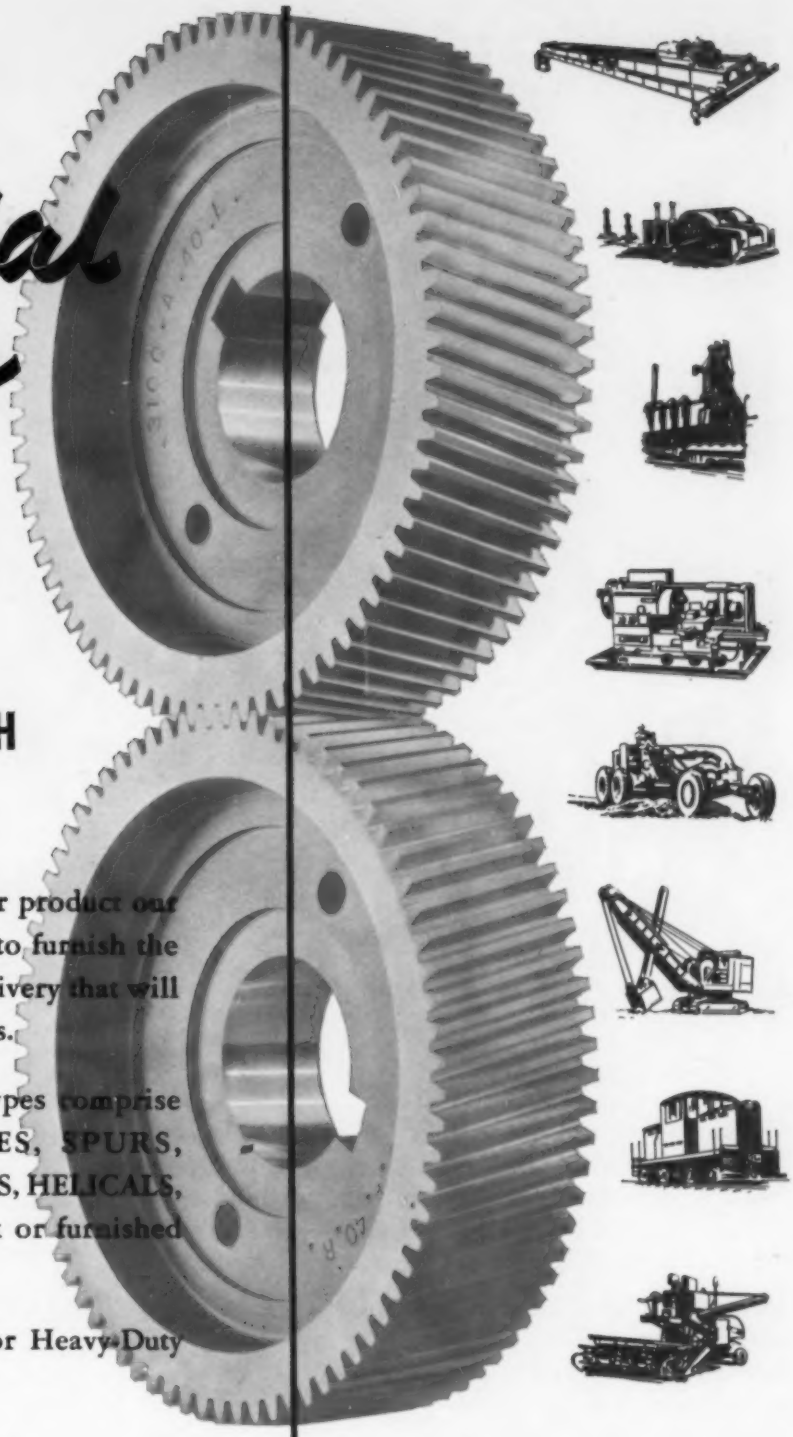
C-215

Industrial Cut Gears



READY TO HELP YOU WITH YOUR GEAR PROBLEMS

If you buy gears for assembling into your product our entire plant and staff are at your service to furnish the finest quality coupled with the kind of delivery that will coincide with your assembly requirements.

We are tooled for any volume—Gear Types comprise HERRINGBONE, BEVELS, MITRES, SPURS, WORMS and WORM WHEELS, SPIRALS, HELICALS, SPLINE SHAFTS, etc.—from your stock or furnished complete.

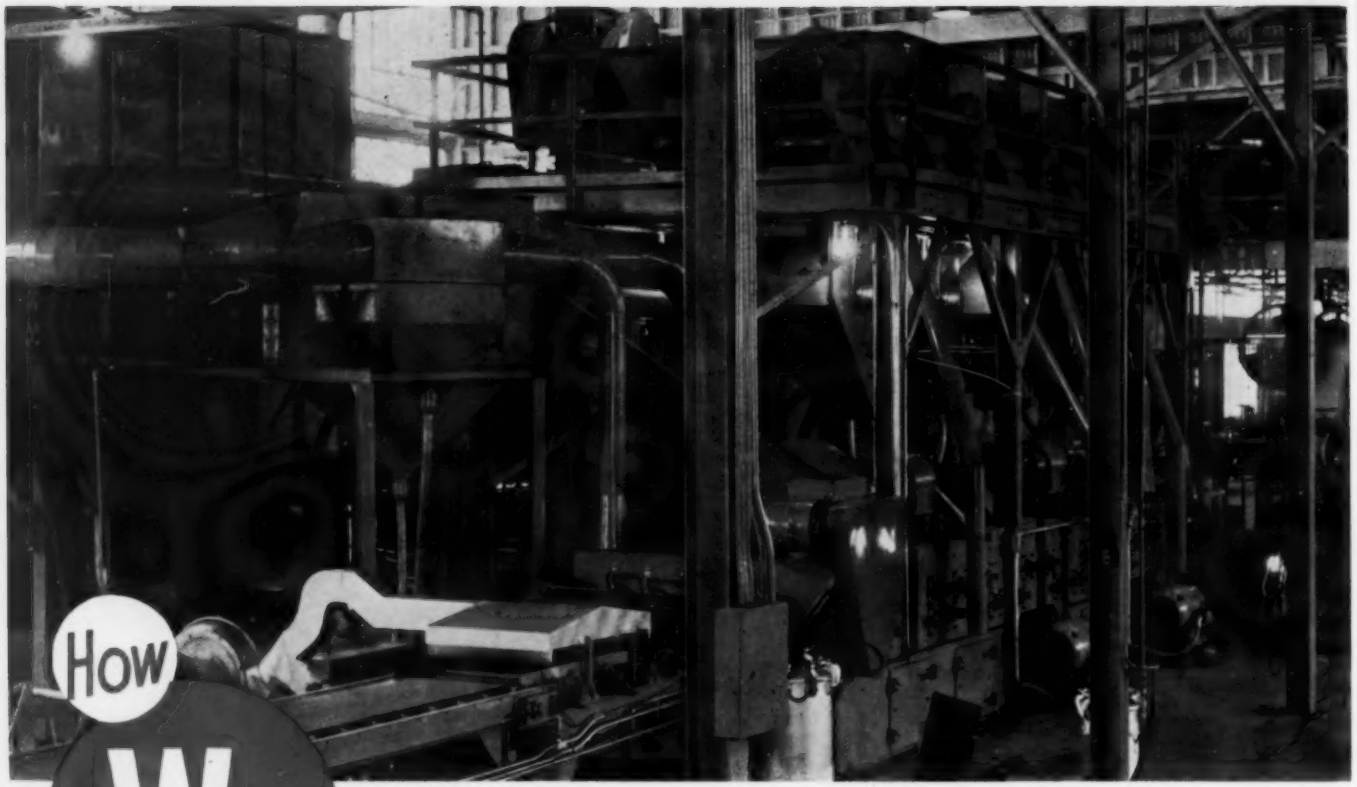
Always specify "GI" Durocase Gears for Heavy-Duty or Steel Mill Service.

See our plant at work pictorially
Write for Brochure "A trip through Industrial"

MEMBER OF AGMA

Industrial Gear Mfg. Co.

4527 W. VAN BUREN ST.
CHICAGO 24, ILLINOIS



How WHEELABRATOR® MECHANICAL CLEANING of Hot Rolled Steel Sheets Reduces Cleaning Costs per Ton

Operating results of airless Wheelabrator mechanical cleaning equipment for removing scale from hot rolled steel sheets have proved that other methods do not equal its cost-cutting performance and high speed cleaning efficiency.

In each of the seven drum plants of Rheem Manufacturing Co., for example, Wheelabrator machines have greatly reduced the cost of cleaning 18-gauge steel sheets used in the manufacture of their new Rheemcote lithographed steel drums. In other steel processing plants and steel mills, the Wheelabrator is also effecting impressive results in low cost, high production and providing extra benefits in improved surface cleanliness and better working conditions.

These production economies are a result of perfected equipment design coupled with the controlled abrasive blast of the Wheelabrator unit. With the introduction of Wheelabrator Steel Shot, equipment operating and maintenance costs are extremely low and continuous, high-production mechanical cleaning of hot rolled products is now in actual practice.

We would be glad to demonstrate the savings the Wheelabrator can make for you. Write today for full details and an appointment to see the Wheelabrator in operation.

WHEELABRATOR — The perfected airless centrifugal blast unit pioneered by American scours away scale and dirt mechanically at low cost. Provides a more uniform etch for mill rolls, effects unusual economies in cleaning strip, sheet, bar stock and skelp.

American
WHEELABRATOR & EQUIPMENT CORP.
396 S. Byrkit St., Mishawaka, Indiana

WORLD'S LARGEST BUILDERS OF AIRLESS BLAST CLEANING EQUIPMENT

ENGINEERING REPORTS:

WORLD'S LARGEST continuous strip annealing furnace is co-ordinated with the G-E drive for a capacity up to 30 tons per hour of 18- to 37-inch strip. Protective gas atmosphere in furnace protects the strip against oxidation.

New line anneals strip at 1000 fpm

Co-ordinated G-E drive and furnace help produce up to 30 tons per hour

Another step toward higher-speed steel-making is the continuous cleaning and annealing line recently started by a large Indiana mill—with co-ordinated G-E drive and annealing furnace. Engineered by G.E. and United Engineering & Foundry Co. to handle a 18- to 37-inch strip at speeds up to 1000 feet per minute, it provides these advantages over batch methods:

SPEEDS OUTPUT with continuous, 24-hour operation.

SAVES TIME. No need to transport coils from cold mill to cleaning unit to furnaces. Annealing cycle is cut, too.

IMPROVES PRODUCT. Furnace's precise temperature control gives strip greater uniformity.

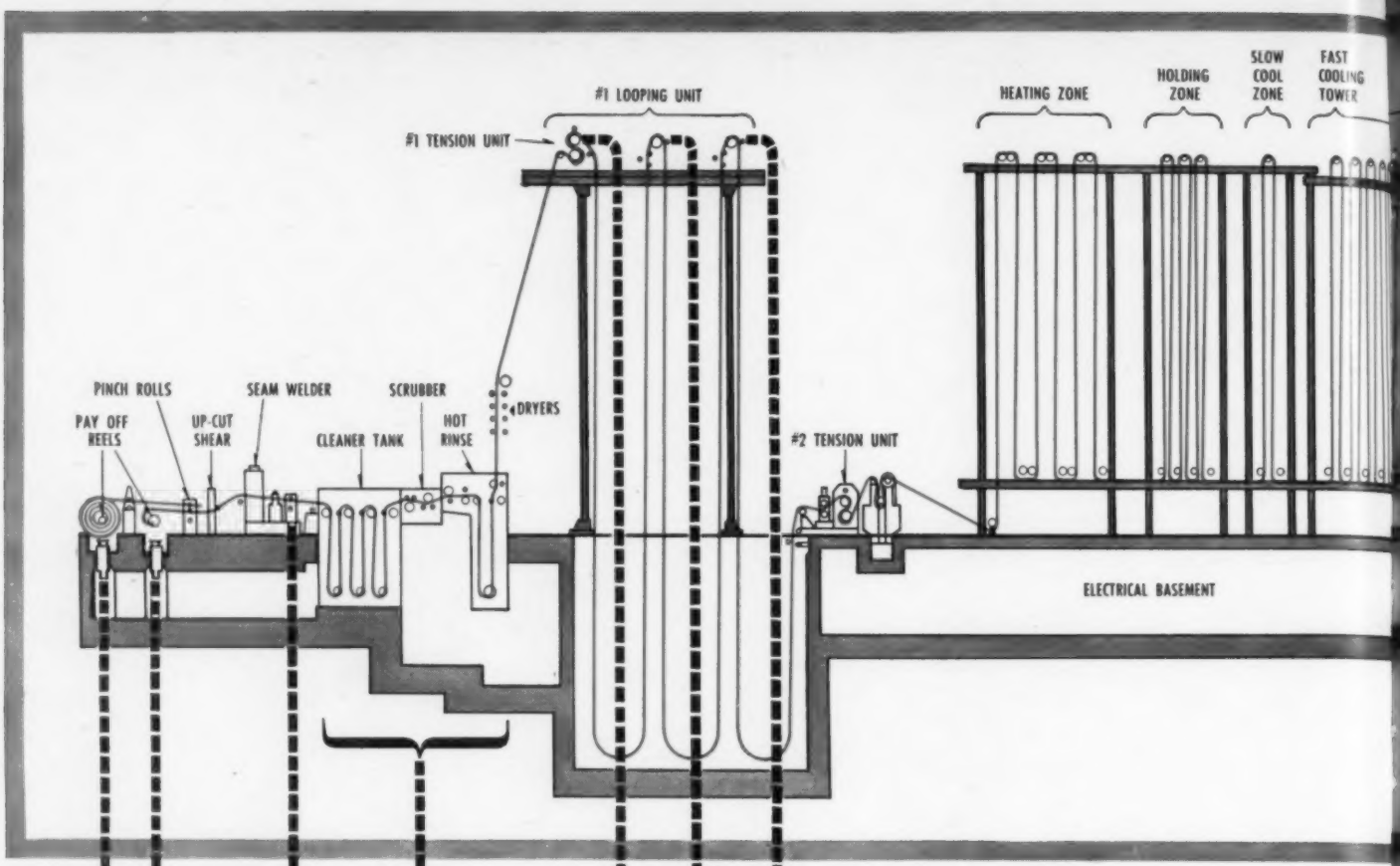
SAVES MANPOWER. Fully automatic amplidyne control of tension, loop position and overspeeding permits operation of entire line by as few as three men.

SAVES SPACE. Continuous cleaning and annealing reduces needed equipment area and storage space.

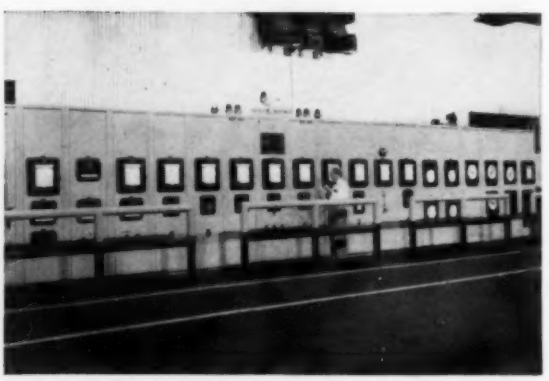
An **engineered system** approach by a G-E steel-mill specialist can help solve **your** drive problems as well. Contact your local G-E Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y. 659-90

For engineering details, turn page

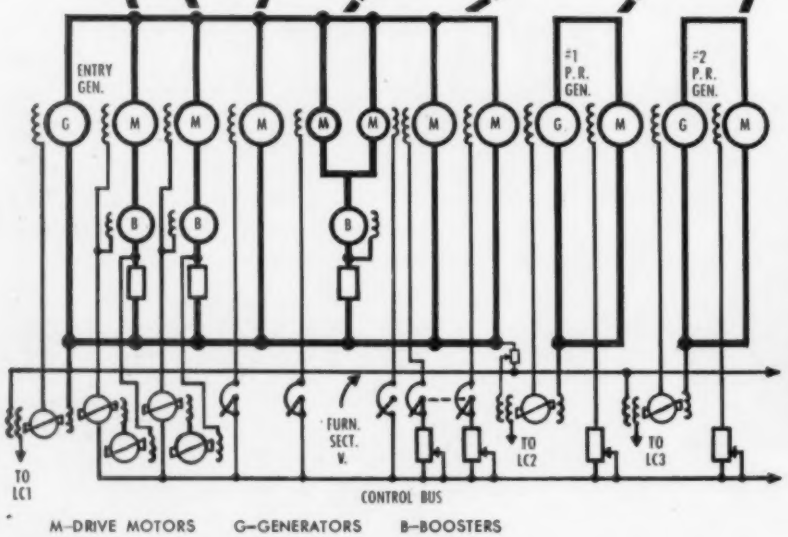
GENERAL ELECTRIC



Anneals strip



PRECISE TEMPERATURES maintained by G-E furnace and furnace-control panel help give strip more uniform physical qualities and surface conditions.

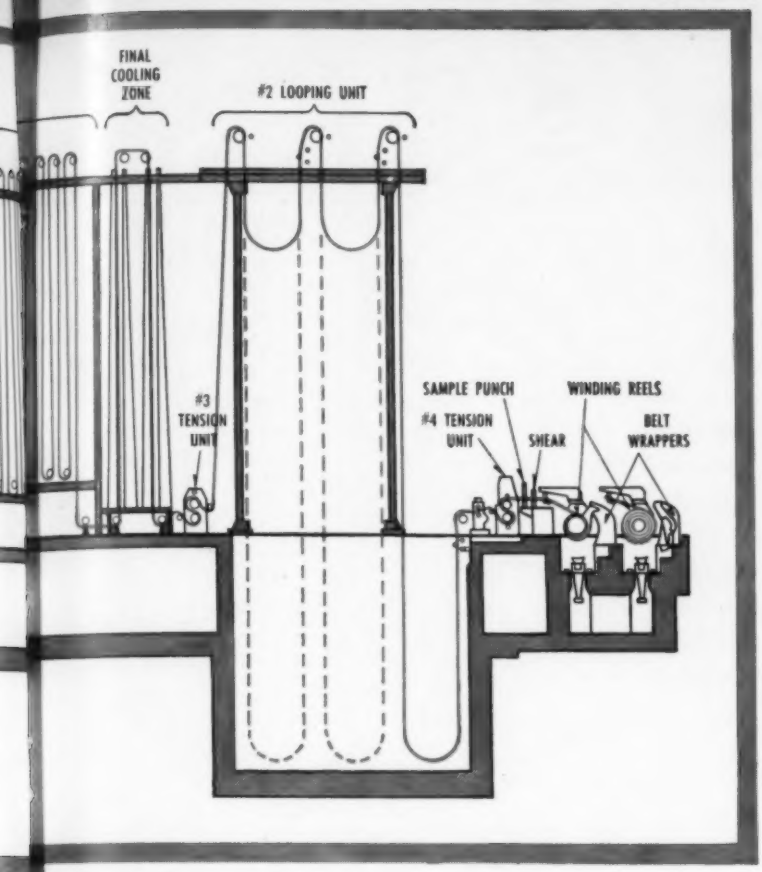


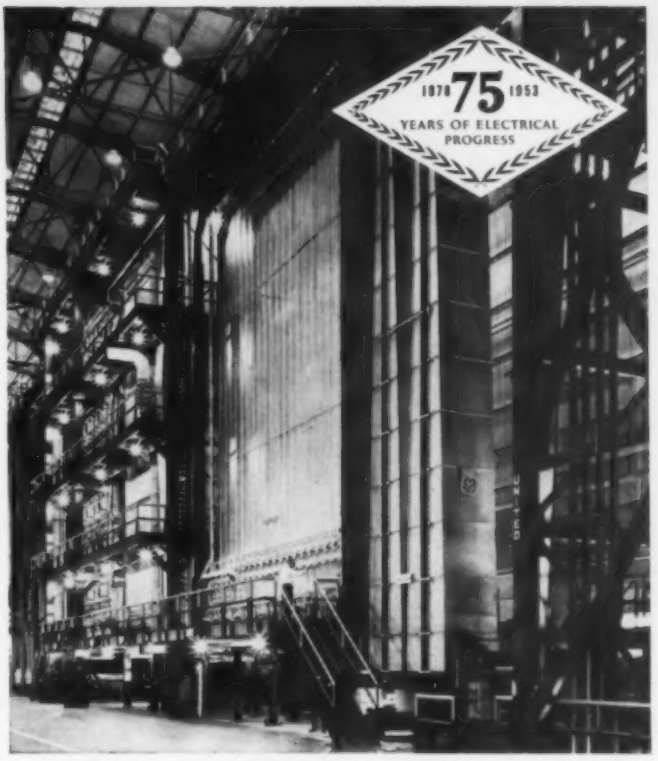
HOW THIS G-E ENGINEERED DRIVE WORKS

A motor-operated rheostat sets line speed by controlling the furnace-section generator voltage. Voltages of the entry and delivery section drives, and the tower pinch rolls, are regulated to keep the entry storage loops full and the delivery storage loops empty during normal running. The furnace-section voltage is used as a reference for an approximate speed match, with the photo-electric loop controls (LC) acting as overriding vernier regulators to maintain accurate loop position.

To start a new coil, the entry section is decelerated to a stop under current limit, while the "half-speed" pinch roll (No. 1PR) empties the loop evenly. This permits the strip to continue through the furnace at a constant speed during the time required to weld together the ends of the new and old coils. The entry section is then accelerated, again under current limit, to an overspeed condition until the storage loops are refilled. Full coils of annealed strip are removed from the delivery end of the line in a corresponding manner.

Another example of G-E drive engineering at work!





CONTINUOUS OPERATION is maintained in the line (shown from delivery end) with help of amplidyne-controlled storage loops for strip between furnace section and each end section.

continuously, more uniformly

13 FEET BELOW main floor—in the "electrical basement"—are these adjustable-voltage m-g sets, and 92 feet of G-E d-c control assembled back to back on a 46-foot-long framework.

64 FEET ABOVE main floor—atop the furnace—these G-E gear-motors drive fast-cooling and final-cooling section rolls. General Electric motors in the entire line total over 1700 hp.

GENERAL ELECTRIC

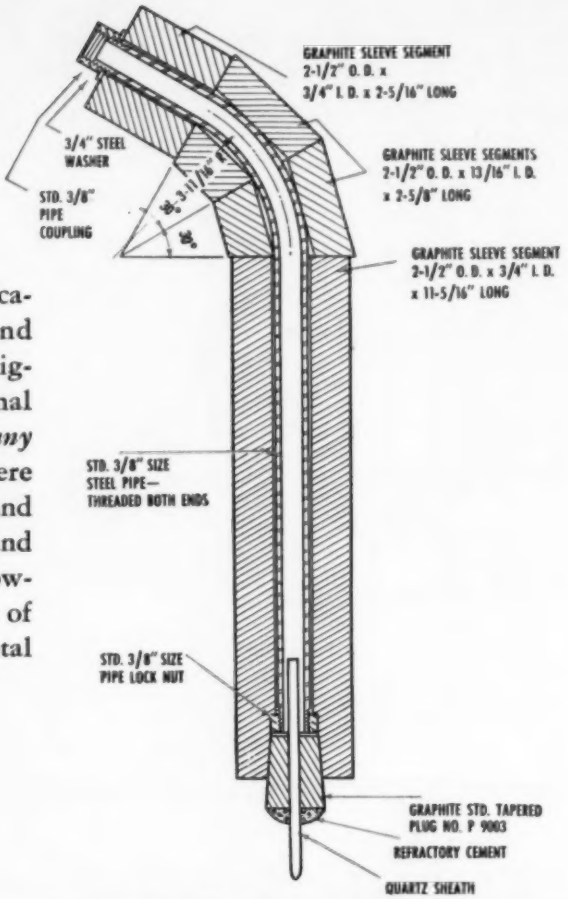
In Furnace and Foundry...

These SMALL PARTS do a BIG JOB

● High temperature applications of "National" Carbon and Graphite are not limited to big-tonnage items. A part of National Carbon's service is to develop *any* application, however small, where the unique properties of carbon and graphite assure a convenience and economy to the user. In the following two instances, a few *pounds* of graphite serve literally *tons* of metal . . . efficiently and at a saving.

"NATIONAL" GRAPHITE FLUXING TUBES

Can't be equalled by any other material for the introduction of purifying gases into molten metal. Graphite can't melt in the bath, can't contaminate the metal. Its low coefficient of expansion prevents cracking and spalling. Metal and dross do not adhere tightly to it. And whatever gases are used, graphite will not corrode.


GRAPHITE SLEEVE SEGMENT
2-1/2" O. D. x
3/4" I. D. x 2-5/16" LONG
3/4" STEEL WASHER
STD. 3/8" PIPE COUPLING
GRAPHITE SLEEVE SEGMENTS
2-1/2" O. D. x 13/16" I. D.
x 2-5/8" LONG
GRAPHITE SLEEVE SEGMENT
2-1/2" O. D. x 3/4" I. D.
x 11-5/16" LONG
STD. 3/8" SIZE STEEL PIPE—THREADED BOTH ENDS
STD. 3/8" SIZE PIPE LOCK NUT
GRAPHITE STD. TAPERED PLUG NO. P 9003
REFRACTORY CEMENT
QUARTZ SHEATH

"NATIONAL" GRAPHITE-SHEATHED THERMOCOUPLE ASSEMBLY (Typical)

Only graphite could provide the degree of low-cost, trouble-free protection required by thermocouple assemblies of this type for the immersion method of measuring open hearth and electric furnace bath temperatures. Reclamation and maintenance for re-use are simple, quick, and economical. Molten metal won't stick to the graphite parts and they're immune to thermal shock.

HERE'S HOW TO LICK HY HEET

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30 E. 42nd Street
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☐ Thermocouple Sheath Parts ☐ Fluxing Tubes

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. . . mark phenomenal acceptance of "EVEREADY" No. 1050 Industrial Flashlight Batteries by a broad cross-section of industry. Delivering twice the usable light of any battery we've ever made before, it will not swell, stick or jam in the flashlight . . . has no metal can to leak or corrode.

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

J. Stewart Williamson who rose from laborer to vice president in charge of operations of Weirton Steel Co., has resigned and is retiring from active duty after 35 years of service with the company. He is being succeeded as vice president by **E. O. Burgham** who moves up from general superintendent. Mr. Williamson will continue in the employ of the company in a consulting capacity. **J. H. Strassburger,** assistant general superintendent, is named assistant vice president assigned to the engineering department in charge of research and development. **Alfred E. Kadell,** advances from manager, Weirton tin mill to general superintendent. **Glenn Gould** succeeds Mr. Kadell as tin mill manager. **Arch Miller,** assistant to manager of the tin mill, moves up to succeed Mr. Gould as assistant manager.

Paul H. Fickenscher has been named manager of the Pittsburgh, Pa., district sales office of Clark Controller Co. Mr. Fickenscher has been a sales representative for the Clark Controller Co. in Pittsburgh since January 1947. Before that he was located at the company's home office in Cleveland, Ohio, where he held the position of application engineer. Prior to his association with Clark Controller Co. he was with the Carnegie-Illinois Steel Corp. at Duquesne, Pa., for seven years.

William C. Wilson has been appointed sales manager of the Mesta Machine Co., Pittsburgh, Pa. Mr. Wilson has been with Mesta for the past 18 years. Prior to going to Mesta, he was employed by the Weirton Steel Co. and the Wheeling Steel Corp.

H. P. Rees has been named assistant vice president at Sharon Steel Corp., Sharon, Pa. Other promotions are: **W. J. McGaffney,** to general works manager, Lowellville works; **Henry Evans,** to general works manager, Roemer works; **W. A. Horning,** to assistant general works manager, Roemer works; **Howard Sahli,** to superintendent of hot strip mills, Roemer works; **R. A. Filer,** to superintendent of finishing division A, Roemer works; **John Murray,** to superintendent of the cold rolling department, Roemer works; **Clarence Houk,** to superintendent of the pickling department, Roemer works; and, **Dale Bartholomew,** to superintendent of blast furnaces, Roemer works. All of the men elevated by the corporation have been Sharon Steel employees for a number of years and reside in the Shenango Valley or surrounding communities.

Raymond C. Gintert, superintendent of hot mills at Republic Steel Corp.'s Warren, Ohio, district operations from 1937 to 1946, will return to Warren as Republic's district manager. Mr. Gintert succeeds the late **Frank E. Flynn,** district manager for 17 years prior to his death on February 19. Mr. Gintert, who joined Republic as a shipping foreman in 1917, recently has been general superintendent of the company's 98-in. strip mill at Cleveland.

Gilfry Ward has been appointed president and **Joseph L. Mullin** first vice president of the American Manganese Steel Division of American Brake Shoe Co. Mr. Ward joined the Amsco division of the company as a trainee in the engineering department in 1928. In 1932 he transferred to the sales department and in 1937 was appointed a district sales manager. In 1938 Mr. Ward was made vice president and in 1948 was placed in charge of sales for the division. Mr. Mullin was formerly vice president in charge of operations of the Amsco division. Mr. Mullin joined the company as a clerk in 1914. He held various jobs in the operating department and in 1928 he was appointed general superintendent of foundries for the Amsco division. In 1945 he became vice president in charge of operations for the division.

Henry F. Peters, who has been technical service engineer in the technical service department of Lukens Steel Co., Coatesville, Pa., has been named manager of that department.

John A. McDougall was named general sales manager of Revere Electric Manufacturing Co., Chicago, Ill.

E. O. BURGHAM

J. H. STRASSBURGER

PAUL H. FICKENSCHER

WILLIAM C. WILSON

V. L. MILLER

J. H. WERNER

J. L. KOZMA

ROBERT CORBETT

John Arnold has been advanced to chief engineer at Lee Wilson Engineering Co., Inc., succeeding **Vernon L. Miller** recently appointed district manager for the

JOHN ARNOLD

company's eastern territory, with headquarters in the New Haven, Conn., area. New district managers also include **J. H. Werner** for the southern and midwestern territory, who will operate out of Chicago, Ill., **J. L. Kozma,** centrally located in his territory at Pittsburgh, Pa., and **R. L. Corbett,** who will continue coverage of Ohio from the company's office in Cleveland, Ohio.

James E. Krajovic has been appointed purchasing agent of the Brosius division of Salem-Brosius, Inc., succeeding **Alfred G. Lewis.** Mr. Krajovic will be located in Salem, Ohio. Mr. Lewis, who is retiring, has been purchasing agent of the Brosius division of the company and its predecessor, the Edgar E. Brosius Co., since 1927; and has been affiliated with the organization since 1913.

Leonard P. Mellgren has been appointed district sales engineer and will head the new district offices of De Laval Steam Turbine Co. in Minneapolis, Minn. The new district offices will be in the Northwestern Bank Building, Minneapolis, Minn. Prior to this appointment, Mr. Mellgren served with the Detroit Stoker Co. as sales engineer.

Joseph V. Schleisner has been named chief engineer of Thermal Transfer Corp., Pittsburgh, Pa. and **Robert J. Sahr** has been named sales engineer. Mr. Schleisner served as chief engineer of Industrie-Companie, Krefeld, Germany, since 1937, and has assisted in the design and erection of more than 7000 thermal recuperation units throughout Europe. Mr. Sahr was with U. S. Steel Corp., Pittsburgh Rolls division of Blaw-Knox Co., Heppenstall Co. and, more recently, was metallurgical development engineer for Silver Engineering Works, Denver, Colo.

Devon W. Fryback has been named sales manager of the eastern region for the Industrial Division of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa. **O. B. Pyle, Jr.** was named industrial manager of the mid-Atlantic area and **Edward J. Klein** was appointed industrial manager for the firm's Philadelphia, Pa., branch office.

John E. Griffith has been named assistant chief industrial engineer of Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Griffith, an industrial engineering graduate of the University of Pittsburgh, joined J&L in 1936 and served at the Aliquippa, Pa., works. He has been on the staff of the chief industrial engineer in the J&L Central office since 1944.

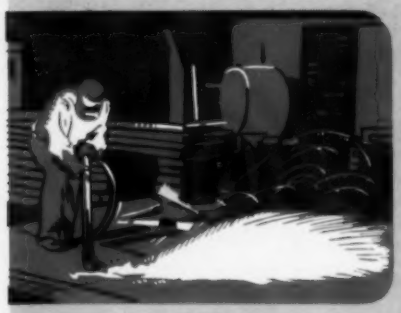
Walter A. Stuhr has been appointed regional sales engineer in charge of the new Midwestern office of May-Fran Engineering, Inc., located at 53 West Jackson Blvd., Chicago, Ill. Mr. Stuhr will represent May-Fran's line of materials handling equipment and mechanized scrap handling systems throughout the central area.

R. M. Pike has been appointed manager of Marathon Electric Manufacturing Corp.'s central region with headquarters in Cleveland, Ohio.

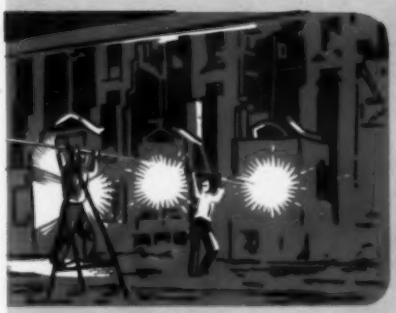
E. P. Roudebush was appointed vice president and works manager for Roots-Connersville Blower division of Dresser Industries, Inc. He will be in charge of all manufacturing activities at the Connersville, Ind. and Delaware, Ohio plants. **D. A. Johann** has been promoted to vice president in charge of sales. Since January 1951, Mr. Johann has been general sales manager.

Now you can make your own

High-Purity OXYGEN and NITROGEN simultaneously — with ONE Generator



Steel Scarfing



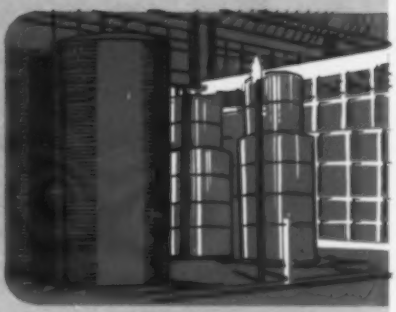
Metallurgical

Chemical-Petroleum

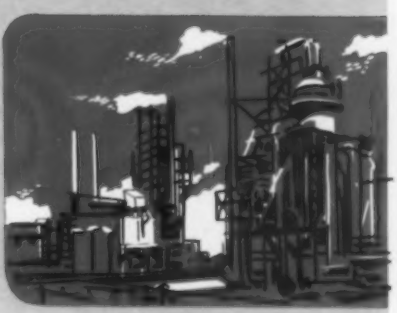
OXYGEN

NITROGEN

Heat Treating



Annealing



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- ★ Both products from one generator
- ★ Use one raw material: the free air
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- ★ Safe, simple—easy to operate

Slash costs of inert gas—*while* you cut costs of high-purity oxygen! Make *both* in your own plant with *one* Air Products Generator. Standard *High-Purity* models are available with oxygen capacities from 2500 to 12,000 cubic feet per hour—nitrogen capacities from 4000 to 36,000 cubic feet per hour. *Liquid* oxygen and nitrogen if desired. Also *Tonnage* Generators in standard models, or of special design. Capacities *unlimited!* Write us your requirements, and send for our CATALOG.

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OXYGEN-NITROGEN GENERATORS

Max W. Demler was appointed salesman in the Minneapolis, Minn., sales office of Harbison-Walker Refractories Co. Prior to this appointment, Mr. Demler had worked in various posts in the engineering, mining and technical sales departments at Harbison-Walker's home offices in Pittsburgh, Pa.

George W. Urban has been appointed purchasing agent of Cleveland Crane & Engineering Co., Wickliffe,

GEORGE W. URBAN

Ohio, to succeed **Henry Karr,** who has retired after over 50 years of service with the company. Mr. Urban was assistant purchasing agent for the past seven years.

J. Louis Irwin was named manager, labor relations for Lukens Steel Co., **A. B. Steele,** became manager, personnel administration, **Earle R. Woodhull** is the wage and salary administrator, **Charles R. Vandever** will be assistant to manager, labor relations, **Ben R. Slocum** becomes supervisor, employment, **Elliott R. Jones** was appointed manager, public relations.

William L. Manly, for the last several years special assistant to the vice president and director of sales at Allis-Chalmers General Machinery Division, has been named assistant director of sales of the division.

Warren Erbe, St. Louis, Mo., sales representative for Electric Service Manufacturing Co., has been named district manager of that office. Mr. Erbe has been with Electric Service for 10 years. **Ray Gawthrop,** of the Philadelphia, Pa., office has been transferred to the Detroit, Mich., office.

Robert W. Evans has been appointed assistant director of public relations for United States Steel Corp.'s western district, with headquarters at 25 Beale Street, San Francisco, Calif. Mr. Evans has been assistant to the director of public relations for the Pittsburgh, Pa., district since 1944.

A. L. Danielson was named manager of the Bailey Meter Co.'s branch office in Denver, Colo., located at 1506 Kearney Street. Mr. Danielson succeeds **G. M. Wallace,** who has recently been appointed an assistant sales manager with headquarters in Cleveland, Ohio.

Lawrence H. Lemke has been appointed general superintendent of D. J. Murray Manufacturing Co., Wausau, Wisc. Mr. Lemke was formerly superintendent of their machine shop.

Robert E. Redenbaugh was named manager of the original equipment division of Lincoln Engineering Co., St. Louis, Mo. He will direct sales of the company's lubricant application devices to the original equipment market. **Albert J. Gruenewald** was made sales manager of the industrial division. Mr. Gruenewald, formerly a sales engineer for the company, replaces **T. V. Picraux** who has been made production manager of both the company's plants.

Richard K. McConkey has been appointed assistant general manager of the industrial division of Timken Roller Bearing Co., Canton, Ohio. Mr. McConkey was formerly district manager of the industrial division at Moline, Ill. In his new position, he succeeds the late **Melvin H. Kuhl.**

John R. Hogan was appointed as a sales agent for northeastern Ohio and Erie, Pa., territory for H. F. Black Equipment Co., Cleveland distributor for Elwell-Parker Electric Co.

Dr. W. A. Thomas has been appointed chief engineer for Electric Products Co., Cleveland, Ohio, and will be responsible for all electrical and mechanical design engineering, development and research. He was formerly manager of electrical engineering. **E. D. Smith** is now consulting engineer and will be responsible for assigned

DR. W. A. THOMAS

engineering projects. **J. J. Unger** becomes manager of electrical engineering and will be responsible for all electrical design activities. **J. R. Williams,** formerly the central planning manager, has been appointed manufacturing manager. **R. H. Worby** has been appointed chief industrial engineer and will be responsible for methods, tools, plant layout, materials handling, plant engineering and maintenance.

Dr. Elburt F. Osborn, associate dean of the School of Mineral Industries at the Pennsylvania State College,

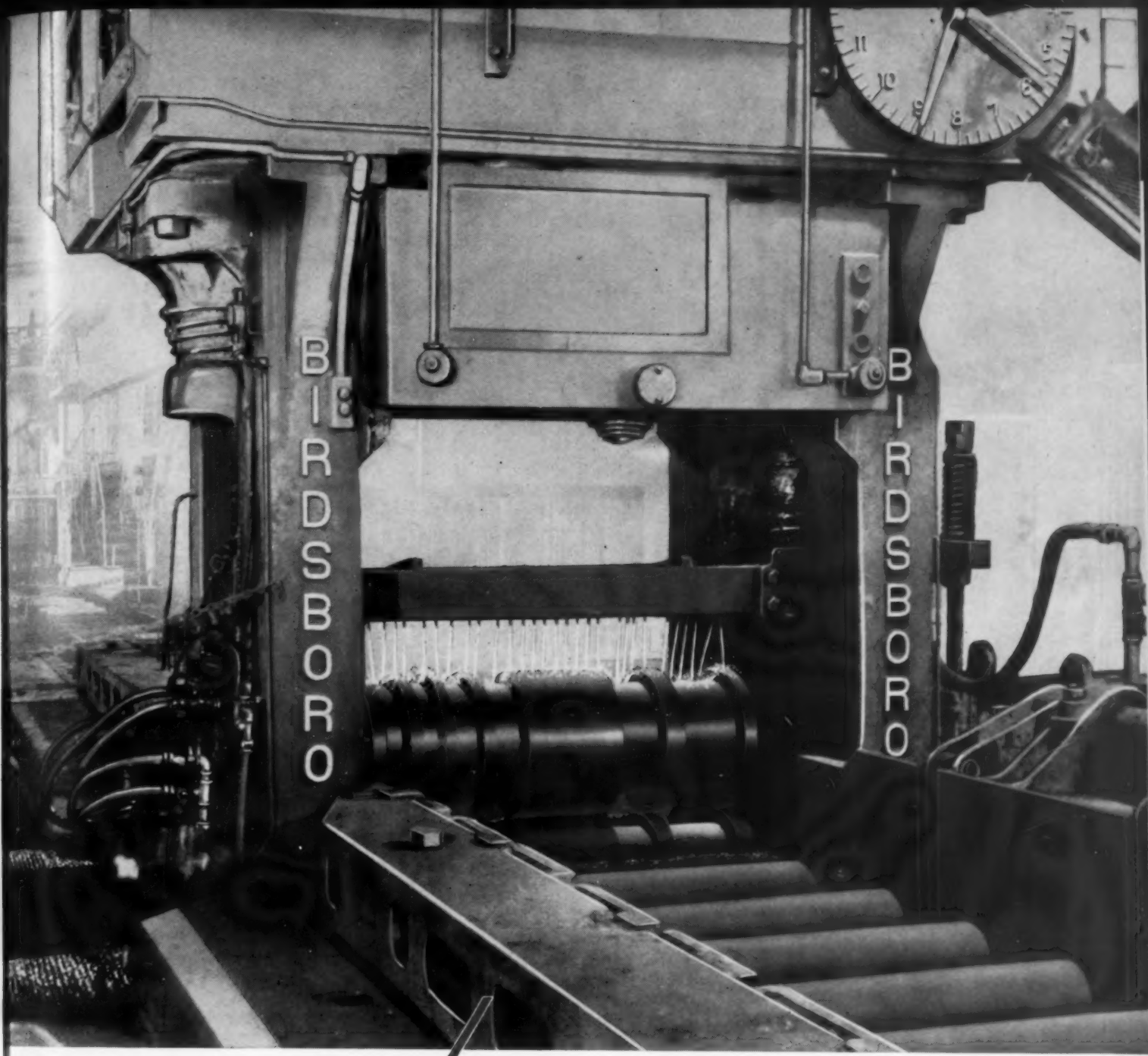

Illustration shows the 22" two-high
Reversing Blooming Mill

SMALL, TWO-HIGH REVERSING MILLS

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designers and builders of: Steel Mill Machinery • Crushing Machinery • Rolls • Hydraulic Presses • Special Machinery • Steel Castings

has been named dean of the school, effective July 1. Dr. Osborn succeeds **Dr. Edward Steidle,** who will retire with emeritus rank on June 30, after serving as dean since 1928.

John E. Thompson, Jr., has been appointed assistant to general superintendent of the Gary, Ind., sheet and tin mill of U. S. Steel Corp. **Isaac R. Yonan** was named superintendent, production planning, Mr. Thompson's former post. Mr. Yonan was formerly assistant superintendent, production planning.

Edward J. Parker has been appointed district sales manager for St. Louis, Mo., and **Edward J. Langhenry** as sales representative in the Chicago, Ill., district sales office of Rockbestos Products Corp. Mr. Parker succeeds **Richard H. Bamford,** who has returned to headquarters as assistant sales manager. Mr. Parker joins Rockbestos after experience as a sales engineer for Peter Kiewit Sons Co. in California, and John Fabick Tractor Co. in St. Louis, Mo. Mr. Langhenry was with the Westinghouse Electric Corp. as a salesman for two years before joining Rockbestos.

Clarence C. Walters was named assistant chief engineer of Republic Steel Corp., Cleveland, Ohio. Mr. Walters came to work for Republic Steel in 1941 as a mechanical engineer. Since that time, he has engaged in engineering work in connection with the manufacturing divisions of Republic Steel, particularly in the development of special machines and equipment, both for regular production and for military production during World War II. In his new capacity, Mr. Walters will assist in supervising engineering for all Republic's manufacturing divisions and will also have charge of the Cleveland engineering department of Reserve Mining Co. (A subsidiary of Republic Steel Corp. and Armco Steel Corp.)

Edgar R. Robbins was named district representative for General Electric's Construction Materials southwestern district. Mr. Robbins was district supply sales manager for General Electric Supply Co. at Lubbock, Tex., and has been active in the electrical trade in the southwest area for a number of years.

In his new assignment, Mr. Robbins will handle the complete construction materials line. His office will be at 418 Terminal Building, Oklahoma City, Okla.

Ray E. Greiner has been appointed director of purchases for Speer Carbon Co., St. Marys, Pa., and its divisions. Mr. Greiner has been with Speer for 10 years and has been the purchasing agent for the International Graphite and Electrode division for the last eight years.

Norman C. Halleck has been appointed to the newly created post of transportation manager, Chicago district, U. S. Steel Corp., with headquarters in Kirk Yard, Gary, Ind. **Charles Iams, Jr.,** succeeds Mr. Halleck as assistant to the general superintendent, Gary steel works, in charge of cost control. Mr. Iams formerly was assistant to the general superintendent of Gary sheet and tin mill.

James R. McCutcheon, Jr., has been appointed sales manager of the valve division of Homestead Valve Manufacturing Co., Coraopolis, Pa. For the past seven years Mr. McCutcheon has served as district representative for American Car and Foundry Co.'s valve division in Western Pennsylvania, Ohio, Kentucky, and West Virginia.

Emil A. Vierow has been appointed superintendent of the Youngstown district fuel and power department by Youngstown Sheet and Tube Co. Mr. Vierow has been connected with Clairton, Pa., coke works, U. S. Steel Corp., Rust Furnace Co., Pittsburgh, Pa., works of Jones & Laughlin Steel Corp., Alan Wood Steel Co., American Steel & Wire division, U. S. Steel Corp. as chief fuel engineer. He joined Youngstown Sheet and Tube Co. in 1944 as superintendent of the fuel department and now has charge of both fuel and power.

Bennett Burgoon, Jr. was appointed sales manager, metal-working division of Kennametal Inc., Latrobe,

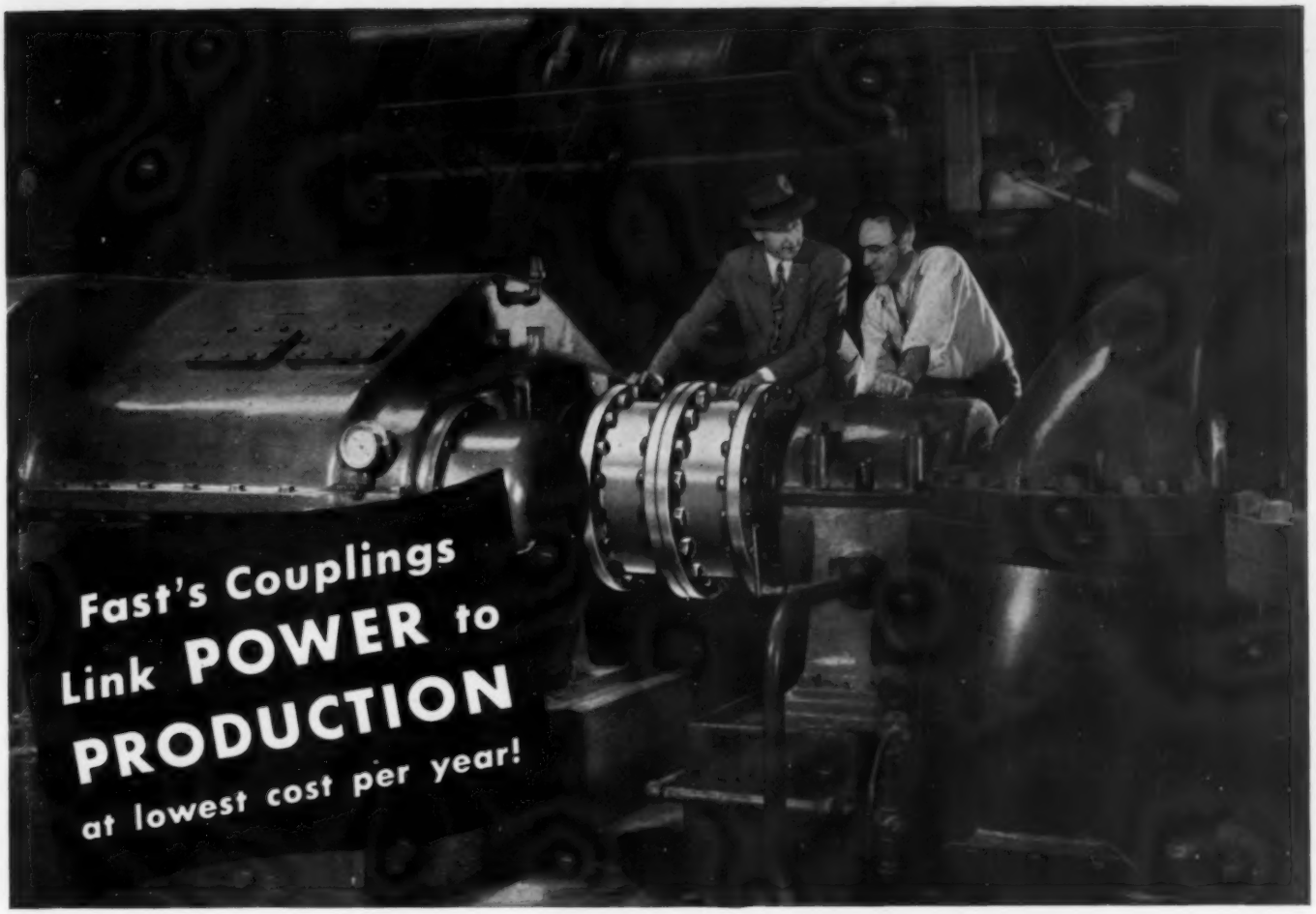
BENNETT BURGOON, JR.

Pa. Mr. Burgoon has been serving as assistant to the general sales manager.

Norman W. Oberg was named as a die sales engineer for Kennametal Inc., Latrobe, Pa. Mr. Oberg has been engaged in diemaking activities for more than 30 years, having at one time operated his own business in Tarentum, Pa. He came to Kennametal Inc. from Firth-Sterling, Inc., and had previously been associated with Gulf Research Laboratories, Lincoln Park Industries, Tools & Gages Inc., and Allegheny Ludlum Steel Corp.

Gale S. Humes has been appointed general manager for Turchan Follower Machine Co., Detroit, Mich. **Otto C. Turchan** becomes sales manager and **Demeter Kiurski** was named chief engineer.

S. L. Jackson was named district manager of the Los Angeles, Calif., office and **R. L. Reed** was appointed district manager of the Detroit, Mich., office of Electro Metallurgical Co., a division of Union Carbide and Carbon Corp.



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THROUGHOUT industry, Fast's are rated the most dependable couplings on the market . . . to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

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Fully Crowned Tooth Design Can Be Used To Solve Your Long-Standing Coupling Problem

A major improvement in gearing for power transmission—a fundamental improvement in gear tooth design that practically eliminates all "end tooth and tip" contact and provides greater freedom of axial movement distinguishes Amerigear Couplings from common gear-type couplings. Amerigear Couplings offer many more advantages than are obtainable with the common basic designs. The Amerigear Crowned Tooth Design can be applied wherever couplings are required. There are many instances where this design has been utilized to simplify power transmission mechanisms and add reliability to their performance in a measure heretofore found impossible.

If your problem arises from excessive offset or angular misalignment, tight back lash requirement, space limitations, high speeds and loads, or any combination of these, the solution is best made by the utilization of the Amerigear Fully Crowned Tooth. Amerigear engineers are available for consultation.

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Fully Crowned Tooth Design Solves Wide Range of Power Transmission Problems.

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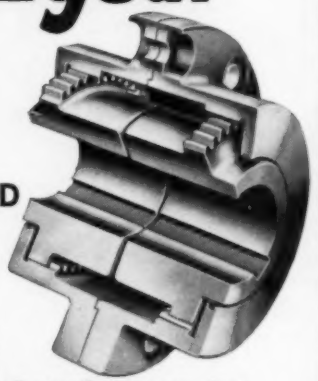


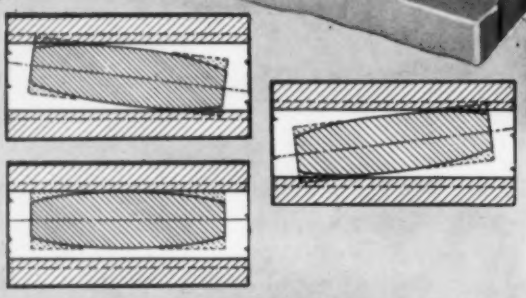
Crowned Tip Contacts Root of Internal Gear Tooth In Sleeve, Accurately Piloting Sleeve With a Ball and Socket Action.

Oil Seals of Amerigear Couplings Are As Advanced In Design, Performance, And Effectiveness As Is The Amerigear Fully Crowned Tooth. Pat. & Pat. Pending

Chamfered to Eliminate Interference With Sleeve at Tooth Fillet and Allow Contact on True Flank of Gear Tooth.

Crowned Flank Carries All the Load and Provides for Correction of Lateral and Angular Misalignments When Required.

Also manufacturers of the original "Oldham Type" American Flexible Coupling



Comparison Of Amerigear Fully Crowned Tooth Design With Gearing Of Conventional Gear-Type Couplings Shows How "End Tooth And Tip" Contact Is Practically Eliminated And Why Greater Freedom Of Axial Movement Is Provided By Amerigear Fully Crowned Tooth Design (dotted lines indicate gear teeth of conventional gear-type coupling).

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Paul McVicker was named technical director of operations of Electro Metallurgical Co., a division of

PAUL McVICKER

Union Carbide and Carbon Corp. His headquarters will be in Niagara Falls, N. Y.

John H. Kilmer, Jr., has been appointed chief engineer, and **Paul A. Brauer,** assistant chief engineer in charge of production of Golden-Anderson Valve Specialty Co., Pittsburgh, Pa.

Obituaries

Frank H. Gordon, 74, retired vice president of Lukens Steel Co., Coatesville, Pa., died February 10. Mr. Gordon had been retired since June, 1948, after having served with the concern 53 years. Mr. Gordon started work as an office boy with the sales department of the concern, then known as Lukens Iron and Steel Co., in 1895 upon his graduation from Coatesville high school. In 1903, after filling various clerical positions, he was named assistant general sales agent, becoming general sales agent in 1907. Mr. Gordon was one of the original incorporators of Lukens Steel Co. in 1917 and served as a member of its board of directors for 12 years. He was elected a vice president June 28, 1928, in which position he served until his retirement on June 30, 1948.

Melvin H. Kuhl, 52, assistant general manager of the industrial division of Timken Roller Bearing Co., Canton, Ohio, since 1945, died recently.

Ralph B. Dimmick, 69, consulting metallurgist for Armco Steel Corp., Middletown, Ohio, died February 12. During his long career with Armco, Mr. Dimmick held many positions in the metallurgical and research departments, and was works metallurgist at Armco's Butler, Pa., plant from 1927 to 1949. Since 1949, he had held the position of consulting metallurgist to Armco.

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OHIO is the *PREMIER* mill magnet

In handling scrap, pigs, ingots—or in any mill application where magnets are subjected to severe blows—you need the extra structural strength of Ohio Magnets.

For example, take this rugged Ohio Protecto-Weld Magnet. The outer ring is a single hefty casting welded to the top plate. This means the weld is on *top* where it can't get dented in. Add to this Ohio's heavy-duty copper strip coils wound in long-lasting insulation and sealed with non-cracking asphaltum.

No wonder Ohio Magnets require less maintenance. So for extra magnet life, extra magnet value—specify Ohio Magnets. And remember, *Ohio Magnets lift as much or more than other magnets of the same size.* A-5718

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Frank E. Flynn

Association of Iron and Steel Engineers
Past President
For 1943

Frank E. Flynn, 68, past president of the Association of Iron and Steel Engineers for 1943, died February 19. Mr. Flynn was district manager of Republic Steel Corp., Warren, Ohio, at the time of his death. Mr. Flynn started in the steel business with Superior Steel Corp., Carnegie, Pa., progressing from the position of water boy to that of boss roller. In 1916, he started in charge of rolling at the Phillips Sheet and Tin Plate Co., which later became the Weirton Steel Co., and during his eleven years' service he became assistant manager and then manager. He went to the Trumbull Steel Co. in 1928, as assistant vice president in charge of operations. This company later became a unit of Republic Steel Corp., and he became district manager, with headquarters at Warren, Ohio.

Publication Service...

MARCH, 1953

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Plate Resistors

A new bulletin has been published describing a complete line of welded plate resistors for ratings up to 150-amperes continuous without internal paralleling of the grids in the section. The "Tab-Weld-X" sections described in this bulletin are a new development and have been included in this revised bulletin. (942-B). Electric Controller & Mfg. Co.

(2) Magna-Clutch

A catalog is available describing an improved mechanical flow and level meter using a magnetic coupling to connect the float in the manometer with the external metering parts. This instrument, known as the "Magna-Clutch" has the mercury manometer completely sealed as there are no stuffing boxes or pressure tight bearings. It is particularly desirable for use on toxic, corrosive, or inflammable fluids because no leakage is possible. Maintenance is exceptionally low since the principal source of trouble, the pressure bearing, is eliminated. Furthermore, the manometer can be inspected and cleaned and the calibration checked without disconnecting the pressure piping. The high accuracy obtained through the use of a very large float, long float travel, and friction-less (magnetic) linkage is maintained even at high static pressures with no hystersis. (915). Penn Industrial Instrument Corp.

(3) Nickel Cadmium Batteries

A bulletin describing the engine starting characteristics of nickel cadmium batteries, has just been issued. The booklet discusses the principles behind the low-internal-resistance and negligible self-discharge qualities of "Nicad" batteries, and outlines the reasons for the long-life and trouble-free reliability of this equipment. The publication also contains a comprehensive list of specifications to be used as a quick reference in determining nickel cadmium battery needs for quick starting of all gasoline and diesel industrial engines. Nickel Cadmium Battery Corp.

(4) Available Steel Plant Equipment

The "Curry List" of available steel plant equipment is a new monthly service sent without charge to interested persons in the iron, steel, and related industries. Primarily composed of used equipment, this list provides a source of dependable equipment, which is available for delivery faster than is possible in securing new equipment. Included in the current issue of the Curry List are reduction units, cranes, shears, electric hoists, a scrap baller, leveler and mill type motor. Albert Curry & Co., Inc.

(5) Condensation Control Charts

A folder has been produced containing charts which claim to show the exact degree of protection from condensation which is afforded by "Insul-Mastic Type D" insulation. According to the folder, Type "D" is a heavy spray applied coating which was produced to be used where a moderate amount of insulation is needed in conjunction with a corrosion preventive. Such cases might be heated storage tanks or the control of condensation on cold pipes and vessels. In the latter case, it is necessary to raise the surface temperature of the pipe or tank in order to reduce sweating or formation of condensation. This is done by insulating. Through the use of the Insul-Mastic charts, it is said to be possible to tell to what degree the surface temperature will be raised after Type "D" insulation has been applied. To determine this the temperature of the equipment and that of the ambient air must be known. Since relative humidity plays the important part in condensation, these charts also show the per cent of relative humidity above which condensation will form on a bare surface at various surface and ambient temperatures. For comparison the charts also show the increased percentage of relative humidity necessary before condensation will occur when the same surface is coated with 1/4 in. or 3/8 in. of this insulation, the surface and ambient temperatures being the same. Insul-Mastic Corp. of America.

(6) Calcium Carbide Injection

A new booklet discussing "Calcium Carbide Injection" is available. This 18 page article, which appeared originally in a Lynchburg Foundry Co. publication, traces this new metallurgical process for treating metals in the molten state through the progressive stages of development in the Airco Laboratories and in customer's plants. The text is supplemented with a profuse collection of diagrams, photographs, test curves and tables. (ADR 81). Air Reduction Sales Co.

(7) Cushioned Valve

A new bulletin is available describing the Golden-Anderson "cushioned" automatic engine stop valve. Featured in this bulletin are the application, fabrication, installation and design along with a complete parts list, dimensions for all sizes and complete specifications. (S-3). Golden-Anderson Valve Specialty Co.

(8) Flow Meters

Available to you is a set of 7 new specification sheets in consolidated style covers flow meter line. Specification sheets 241 and 242 cover electric evenly graduated flow meter bodies and mechanical evenly graduated flow meters respectively. Specification sheets 243 through 247 cover square root flow meters and liquid level meters. Specification sheet 244 also includes evenly graduated electric flow meters (inductance bridge receivers). Construction and engineering details are included. Minneapolis-Honeywell Regulator Co., Industrial Division.

(9) Power Transformers

A new bulletin on power transformers has just been published. Featured in the brochure are design and construction features, including method of eliminating leaks, shot blasting, undercoating, flanged drain valve and sampling device, and testing and inspecting

procedure. These power transformers are available in sizes up to 10,000 kva, 115 kv. (130) R. E. Uptegraff Manufacturing Co.

(10) Low Voltage Switchgear

A complete new line of low-voltage drawout switchgear (600 volts a-c and below) with standardized compartment construction and completely new air circuit breakers, has been announced in two catalogs available to you. Complete equipments having whatever circuit pattern is needed can be manufactured for shorter shipment from standardized circuit breaker, control—instrument and bus compartment building blocks. Able to withstand 30-cycle momentary currents equal to their interrupting ratings (15,000 to 100,000 amperes), the new air circuit breakers used in the equipment make it possible for the first time to have fully selective tripping with all breakers applied up to their full interrupting ratings. Continuous current ratings range from 15 to 4000 amperes. (GEA-5915, GEA-5916). General Electric Co.

(11) Maintenance Equipment

A 68-page book on "Equipment for Better Maintenance, Safety and Production" is available. The book, which is the 40th anniversary edition, covers tools and equipment that can be divided into five general classifications: Commutator, motor, and generator maintenance; electrical and mechanical maintenance; metal working tools; flexible shaft machines; and, safety equipment. The catalog is most complete and includes prices. Every maintenance department should have this book in their files. (29, Jan. 53). Martindale Electric Co.

(12) Crane Cab Conditioning

A new booklet illustrates and describes the complete line of Lintern "Aire-Rectifiers" for overhead cranes, seven models to meet all requirements in cooling, filtering, and heating, for all temperature ranges and all sizes of cabs. Also two cab heater models for heating and filtering. Each model is fully covered and its application given, so that, with this booklet, you can select the unit for the particular temperature range of the crane in mind. The description is supplemented with a chart showing the list of applications (type of crane operation), temperatures encountered, and model recommended for the particular conditions. By selecting the air conditioner of the proper size for the job, substantial savings are possible as compared with buying a unit designed for high temperature ranges when one for lower temperatures would answer the purpose satisfactorily. (AC-533). Lintern Corp.

(13) Temperature Control Manual

Just published is a new edition of a manual titled "The Design and Process Engineers Guide to Industrial Temperature Measurement and Control." This newly-revised manual, available without charge to process engineers, plant managers, design engineers, and heating engineers, presents the basic principles of industrial temperature control in practical fashion. It defines different types of control systems and distinguishes between them so that the engineer can select the type most suited to a particular application. The manual discusses: the eight ways of responding to temperature; the five ways of putting that response to work; and the nine basic Partlow instrument types. It then takes up evaluation of systems and the important considerations in application engineering. Typical control circuits and piping system arrangements, as well as the ranges and calibrations of scales and dials are presented diagramatically. (101). Partlow Corp.

(14) Bus Ducts

Bus duct application to distribution systems of industrial buildings is described in a booklet available to you. Four types of bus duct are described: (1) plug-in duct—provides outlets every 12 inches; (2) low-impedance duct — for long feeder runs or where minimum voltage drop is important; (3) weatherproof feeder duct—for outdoor installations; (4) weatherproof low-impedance duct. Photographs and application data from actual installations show how bus duct solves distribution problems connected with modernization, expansion, or new building programs. The use of prefabricated elbows, tees and crossovers, and new sliding-type cantilever hangers to make runs of bus duct in any direction, around obstructions and corners, is also described. (B-5835) Westinghouse Electric Corp.

(15) Plate Magnet Separators

A new brochure on low-cost permanent non-electric Model C plate magnets, applicable to all but the heaviest tramp iron removal problems, has just been issued. Typical installations of these separators, widely used in processing lines, are illustrated with engineering drawings and photographs. The permanent separators are not affected by water or temperatures up to 650 F. They are capable of trapping and holding tramp iron in material flows up to 2 in. in depth. These high-strength Alnico V magnets are expressly designed for installation in wood spouts, chutes, hoppers, feed tables and for suspended application above slow-moving conveyor lines. The magnets incorporate stainless steel cap plates which insulate the pole plates and assure added protection against abrasion. These units are built in a range of sizes from 4 in. to 24 in. in width. (No. B-603). Eriez Manufacturing Co.

(16) Heat Exchangers

The publication of a new catalog section, covering "Karbate" Brand Impervious Graphite standard heat exchangers, is announced. The catalog fully describes the Series 310A and Series 90A standard heat exchangers, which replace, respectively, the Series 240A and Series 70A. The new exchangers, which feature lower cost per unit area of heat transfer surface, employ completely removable "Karbate" impervious graphite tube bundles with stainless steel baffles, separate and removable "Karbate" impervious graphite fixed and floating end covers, interchangeable single end multi-pass construction, rugged Type SN cover connections, overside shell connections with built-in vapor belts and impingement plates, and numerous other improvements. The Series 310A and Series 90A "Karbate" heat exchangers possess all the recognized advantages of "Karbate" brand impervious graphite for corrosive service, including: chemical resistance to practically all corrosive fluids, resistance to severe thermal shock, high heat transfer rates, and low maintenance costs. Included in the catalog are complete specifications of sizes, tube areas, operating temperatures and weights, together with engineering drawings showing dimensions, construction and replacement parts. Numerous charts, such as Fluid Pressure Drop, Fluid Velocity, and Typical Overall Coefficients for Non-Scaling Fluids, as well as comprehensive design information and installation and operating facts and suggestions are also included. (S-6740). National Carbon Co., a division of Union Carbide and Carbon Corp.

(17) Mill Control Pulpit

A booklet is available describing modern mill control pulpits. Steel mill designers recognize the fact that the operator must concentrate on the vital job of controlling expensive equipment, the successful

operation of which directly affects the overall mill output. The modern mill control pulpit has been an outstanding development in new and modernization mill construction programs in recent years, and have produced higher efficiency, lower labor turnover and a general "dressed up" mill atmosphere. The pulpits engineered to suit each condition are insulated against heat, have acoustic ceilings and sound deadening heavy steel walls and floors, indirect lighting and concealed wiring. Conduit and cable space is provided under the entire floor area. Heavy shock resistant glass is provided for the operator's protection and light glare. Practical accessory equipment being included are air conditioning, special operator's chairs, control desks, inter-communication systems, industrial television, toilets, lavatory, clothes lockers, showers, drinking fountain, filtered and heated ventilating air, walkways and stairs. Pulpits are shipped completely assembled and painted, have crane lifting eyes and skids making easy installation. James Campbell Smith Inc.

(18) Flexible Gear Coupling

A catalog has just been released covering the revolutionary new Sier-Bath flexible coupling. Discussed are the advantages, typical applications, standard and special types, and engineering data. The coupling, according to the bulletin, transmits more horsepower with less size and weight of coupling. It can be assembled or uncoupled in seconds. No wrenches or special tools are required. (C-4). Sier-Bath Gear and Pump Co., Inc.

(19) Process Controls

The services of a new organization specializing in the designing, engineering and building of special equipment, coordinated process controls and panelboards are described in a new bulletin available to you. Featured in this bulletin are the key men of this organization, along with a list of those industries where their services can best be utilized. Equipment & Controls Engineers Inc.

(20) Coil and Sheet Slitters

Basic information on design, selection and operation of slitting equipment, with time studies and analysis of operating cycle is contained in an excellent book that is available. Discussion of coil handling and scrap disposal is included. Engineering data is given on Yoder rotary gang slitters, uncoilers, scrap choppers, recoilers, coil cars, unloaders, etc. Yoder Co.

(21) Pneumatic Positioning Operator

A pneumatic positioning operator designed for high speed positioning and regulating of heavy equipment is fully described in a bulletin recently published. Operation of the high capacity valve and actuating mechanism which enable the operator to overcome starting friction and inertia is explained and illustrated. The bulletin contains clearance dimensions for mounting the operator at almost any angle. (S-15). Republic Flow Meters Co.

(22) Flow Meter

A pneumatic electric flow meter for measuring widely fluctuating flows, dirty fluids and other difficult fluids is described in a new bulletin recently issued. The flow meter can be adapted to operate at static pressures as high as 2000 psi and differential pressures 0.6 to 704 in. water. Reading instruments having evenly graduated charts and dials may be several hundred feet from the point of measurements. Hook-ups, meter components and applications are discussed and illustrated. (704). Republic Flow Meters Co.

(23) Selenium Rectifier Stacks

A new 28-page, two-color booklet describing the basic characteristics and the applications of selenium rectifier stacks has been announced by the lighting and rectifier department of the General Electric Co. Designated as GET-2350, the booklet is complete with charts, graphs, and tables illustrating the principles of rectification, and the characteristics, manufacture, circuit design, and application of selenium rectifiers.

(24) Combustion Indicator

Another photo-electric relay application, in the form of a Hazegage Combustion Indicator, is described in quite some detail in a bulletin now available. Since the proper ratio of air and fuel is a constant concern to design, plant, and operating engineers, the bulletin may well prove to be the long-sought ready reference to fuel savings through increased combustion efficiency. Wiring diagrams of installation and relay circuits are included in the bulletin. (801). Ess Instrument Co.

(25) Steel Castings

"The Steel Castings Industry — Build With Steel Castings," a booklet designed to acquaint you with the products of the steel foundry, contains a chart entitled "General Engineering Types of Steel Castings" which has been found useful as a guide to design engineers and others in determining the proper steel casting specifications. Steel Founders' Society of America.

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50	AIR PRODUCTS, INC.		Catalog available on Air Products generators.
51	AJAX FLEXIBLE COUPLING CO., INC.		Bulletin available on Ajax dihedral couplings.
52	AMERICAN CHEMICAL PAINT CO.	BULLETIN 13	Describes efficient pickling with rodine; 4-page general descriptive folder and rodine selection chart also available.
53	AMERICAN FLEXIBLE COUPLING CO.	CATALOG 501	Gives details on flexible couplings.
54	AMERICAN MANGANESE STEEL DIVISION, AMERICAN BRAKE SHOE CO.		Catalog sheet available on Thermalloy 4.
55	ANKER-HOLTH DIVISION, WELLMAN ENGINEERING CO.		Bulletin contains information on the complete line of Anker-Holth products.
56	BLISS CO., E. W.	BULLETIN 40	Gives details on Bliss mills.
57	BROOKS OIL CO.		20-page brochure available on the Brooks oil story.
58	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Browning mill type cranes.
59	CONE-DRIVE GEARS DIVISION, MICHIGAN TOOL CO.	BULLETIN 789-50	Cone-Drive gears and reducers.
60	CURRY AND CO., INC., ALBERT		Curry list of available steel plant equipment.
61	ELECTRIC CONTROLLER AND MFG. CO.	BULLETIN 942	EC&M welded plate resistors.
62	ELECTRIC SERVICE MANUFACTURING CO.		4-page folder available on Keystone aluminum conductor system.
63	FARNCO SALES CO.		Catalog describes the Farnco all-purpose materials conveyor.
64	FARREL-BIRMINGHAM CO., INC.		Bulletins available giving complete specifications on roll grinders.
65	FARVAL CORP.	BULLETIN 39	Tells about the DC20 pumping unit for smaller machines.
66	FLOWER MANUFACTURING CO., D. B.	CATALOG 41	Flower brush holders.
67	FOOTE BROS. GEAR AND MACHINE CORP.	BULLETIN GMA	Foote Bros.-Louis Allis gearmotors.
68	FULLER CO.	BULLETIN C-5	Fuller rotary compressors.
69	GARLOCK PACKING CO.	CATALOG 10	Garlock Klozure oil seals.
70	GENERAL ELECTRIC CO.	BULLETIN GEA-5409A	G-E limitamp control.
71	HAUCK MANUFACTURING CO.	CATALOG 410	Describes Hauck oil burners.
72	HEIL PROCESS EQUIPMENT CORP.	BULLETIN 43-A	Heil steam jet agitators.
73	IDEAL INDUSTRIES, INC.		Handbook available on commutator and slip ring maintenance.
74	INDUSTRIAL GEAR MFG. CO.		Brochure describes a trip through Industrial.
75	JONES FOUNDRY AND MACHINE CO., W. A.	CATALOG 83	Describes Jones conveyor pulleys.
76	KOPPERS CO., INC.		Catalog gives detailed descriptions, engineering drawings, capacity tables and photographs.
77	LINTERN CORP.	BULLETIN AC-533	Tells about crane cab conditioning.
78	MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIVISION	DATA SHEET 6.7-8a	Instrumentation data sheet available.
79	PITTSBURGH LECTROMELT FURNACE CORP.	CATALOG 8	Lectromelt furnaces.
80	POOLE FOUNDRY AND MACHINE CO.		Catalog describes flexible couplings.
81	POST-GLOVER ELECTRIC CO.	BULLETIN 500	P-G steel grid resistors.
82	POST-GLOVER ELECTRIC CO.	BULLETIN 400	Describes P-G master switches.
83	REPUBLIC FLOW METERS CO.	BULLETIN 802	Republic low pressure instruments.
84	SPRAYING SYSTEMS CO.	DATA SHEET 3997	Tells about descaling nozzles.
85	TAYLOR CHAIN CO., S. G.		Catalog available on alloy steel chain.
86	TRABON ENGINEERING CORP.	BULLETIN 529	Gives details on Trabon systems.
87	UNITED STATES GRAPHITE CO.		40-page catalog gives information on standard USG brushes.
88	WAGNER ELECTRIC CORP.	BULLETIN MU-132	Describes Wagner type JP motors.
89	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-4595	Westinghouse d-c motors.

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IRON & STEEL ENGINEER

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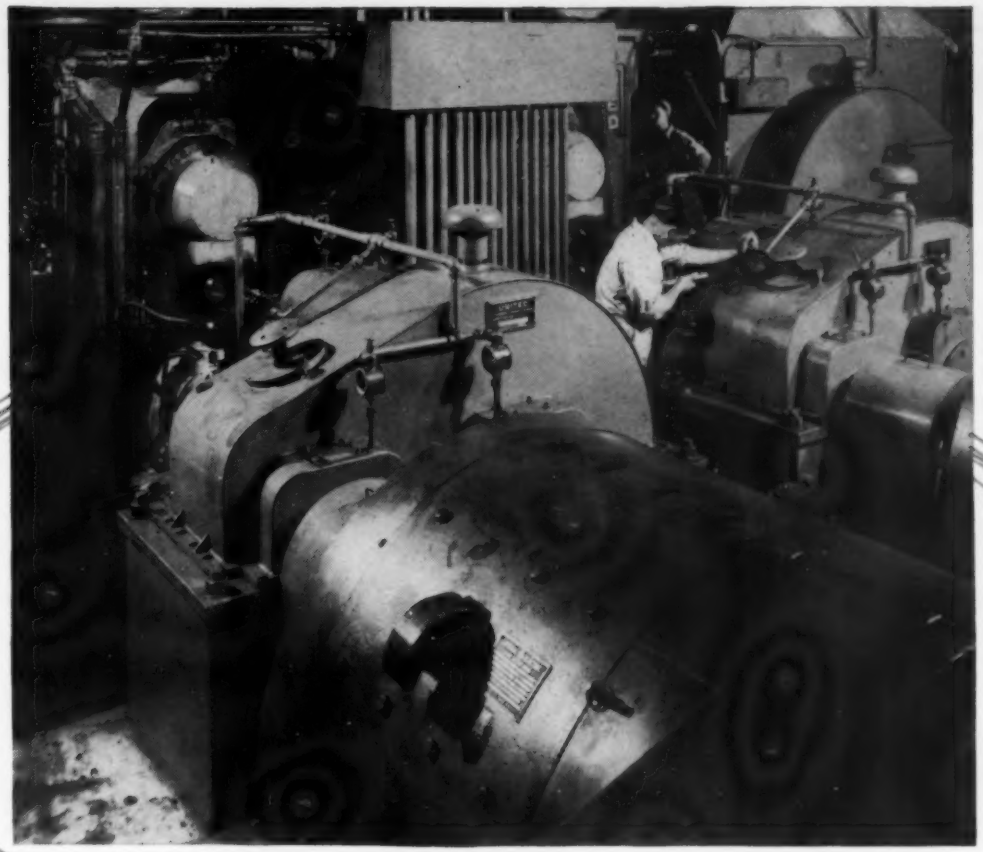


Gulf E. P. Lubricants

have what you want and need in a gear lubricant

1 **TACKY** · don't squeeze out

2 **LOW POUR POINT** easy starting

3 **STABLE** · don't deteriorate

4 **NON-CORROSIVE** good for screw-downs

All the desirable properties of gear lubricants are combined in Gulf E. P. Lubricants to insure longer gear and bearing life and lower costs for maintenance.

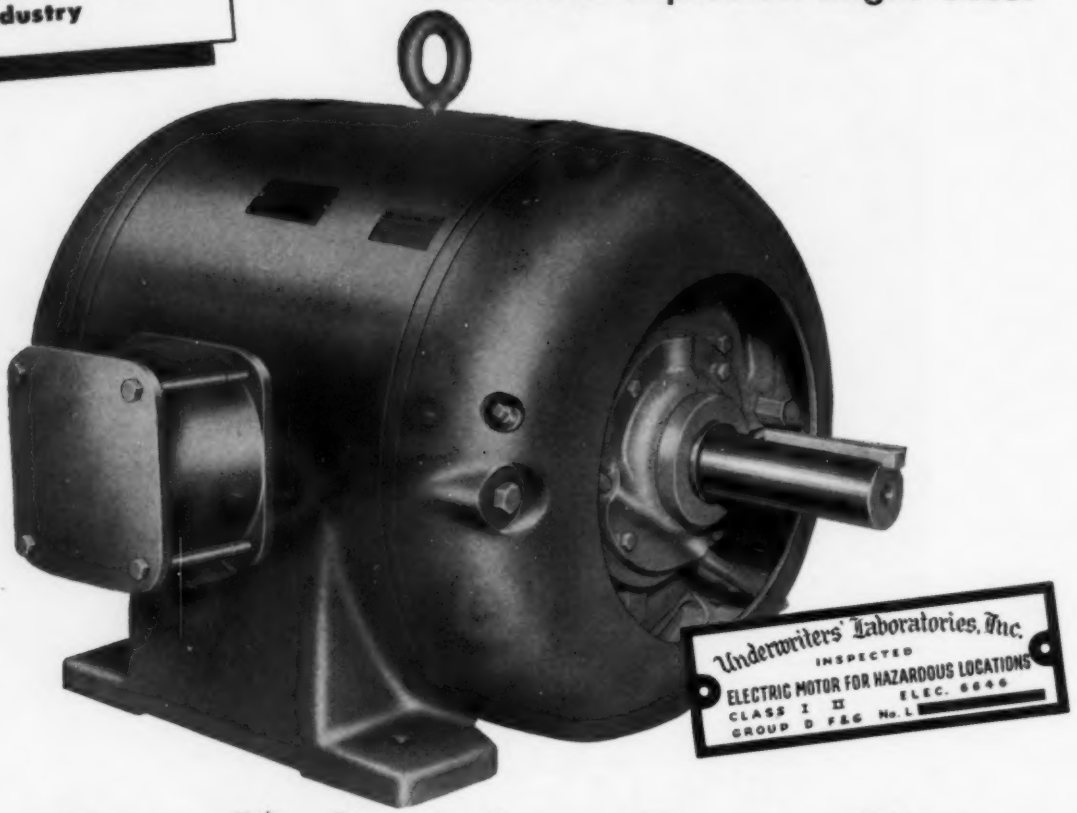
Gulf E. P. Lubricants are specially compounded to prevent welding and pitting. Their extra tackiness permits use of a lower viscosity grade than is possible with a straight mineral oil. This means reduced operating temperatures. Ask a Gulf Sales Engineer for additional information. Write, wire, or phone your nearest Gulf office.

GULF OIL CORPORATION · GULF REFINING COMPANY · PITTSBURGH 30, PENNSYLVANIA

GULF INDUSTRIAL LUBRICATION

Wagner
ELECTRIC MOTORS
...the choice of leaders in industry

...where corrosion is a problem
...where explosion might occur



Wagner Type JP Cast Iron Frame Motors

Wagner type JP cast iron frame motors are built for use in chemical plants, oil fields, refineries, steel mills—for any application where corrosive and explosive conditions might prevail.

These rugged motors are totally-enclosed in rust- and corrosion-resistant cast iron. They are fan-cooled by an externally mounted blower, made of non-sparking bronze, that forces air through ventilating passages in the frame. They feature completely protected laminations . . . special varnish treated windings . . . a running shaft seal . . . and an explosion-proof conduit box with machined fits.

A standard type cast iron frame motor (for applications where protection against explosion is not required is also available. Both types are built in ratings from 2 to 250 hp, with either normal or high torque characteristics.

Wagner Bulletin MU-132 gives complete information on these protected motors. A nearby Wagner engineer can help you select a Wagner Motor to meet your most exacting specifications. Consult the nearest of our 32 branch offices, or write us.

®Wagner Electric Corporation
EST. WE 1891

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

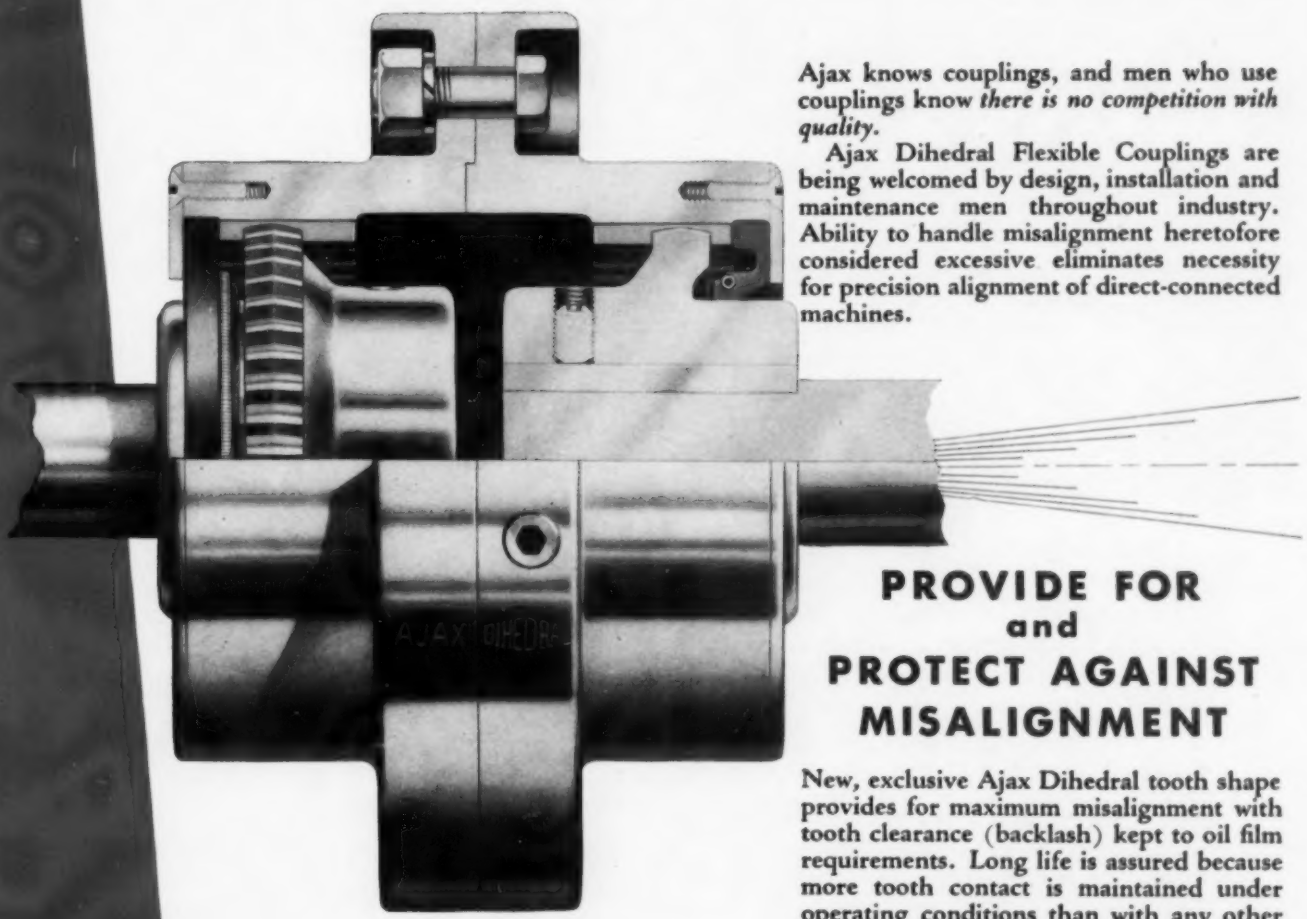
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

M53-9

AJAX DIHEDRAL
FLEXIBLE COUPLINGS

Greatest Major Improvement in Couplings in 30 Years



Ajax knows couplings, and men who use couplings know *there is no competition with quality.*

Ajax Dihedral Flexible Couplings are being welcomed by design, installation and maintenance men throughout industry. Ability to handle misalignment heretofore considered excessive eliminates necessity for precision alignment of direct-connected machines.

PROVIDE FOR and PROTECT AGAINST MISALIGNMENT

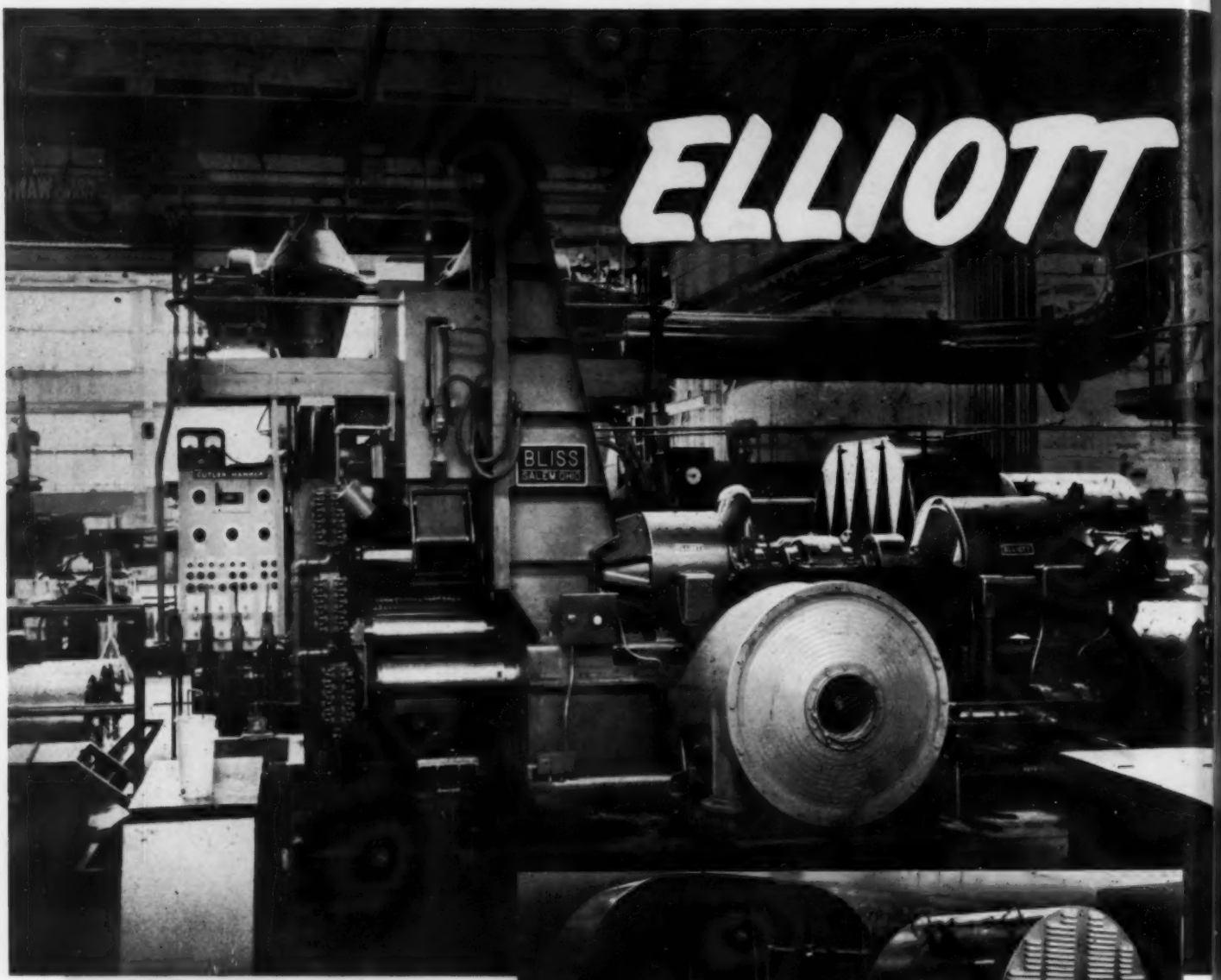
New, exclusive Ajax Dihedral tooth shape provides for maximum misalignment with tooth clearance (backlash) kept to oil film requirements. Long life is assured because more tooth contact is maintained under operating conditions than with any other shaped tooth. 30 degree involute splines provide strong, basic tooth form. Positive seals keep lubrication in and dirt out.

If you use flexible couplings it will pay you to write for Ajax Dihedral Coupling Bulletin

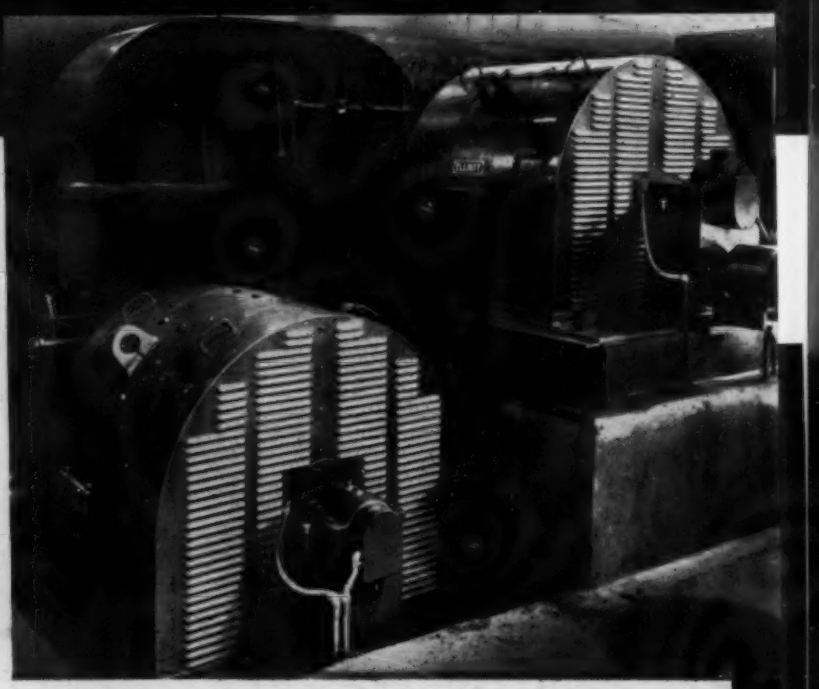
Stock couplings are built to handle misalignment up to 4°.
Teeth can be cut to order to handle greater misalignment.

AJAX FLEXIBLE COUPLING CO. INC.

WESTFIELD, NEW YORK.



Delivery end of mill, with Elliott 20-hp and 75-hp, 300/1200-rpm reel motors in tandem at right, for adjustable tension on heavy and light strip. Duplicate motors drive reel at opposite end of mill.



Twin drive for mill back-up rolls ▶ with two Elliott 300-hp, 450/900-rpm motors. All machines are designed for fast acceleration and deceleration.

Elliott five-unit 740-kw generator set provides adjustable ▶ voltage power for mill motors and reel motors. Ventilating equipment in background. All machines are force-ventilated.

motors and generators

...drive four new reversing cold strip mills for Revere Copper and Brass Incorporated

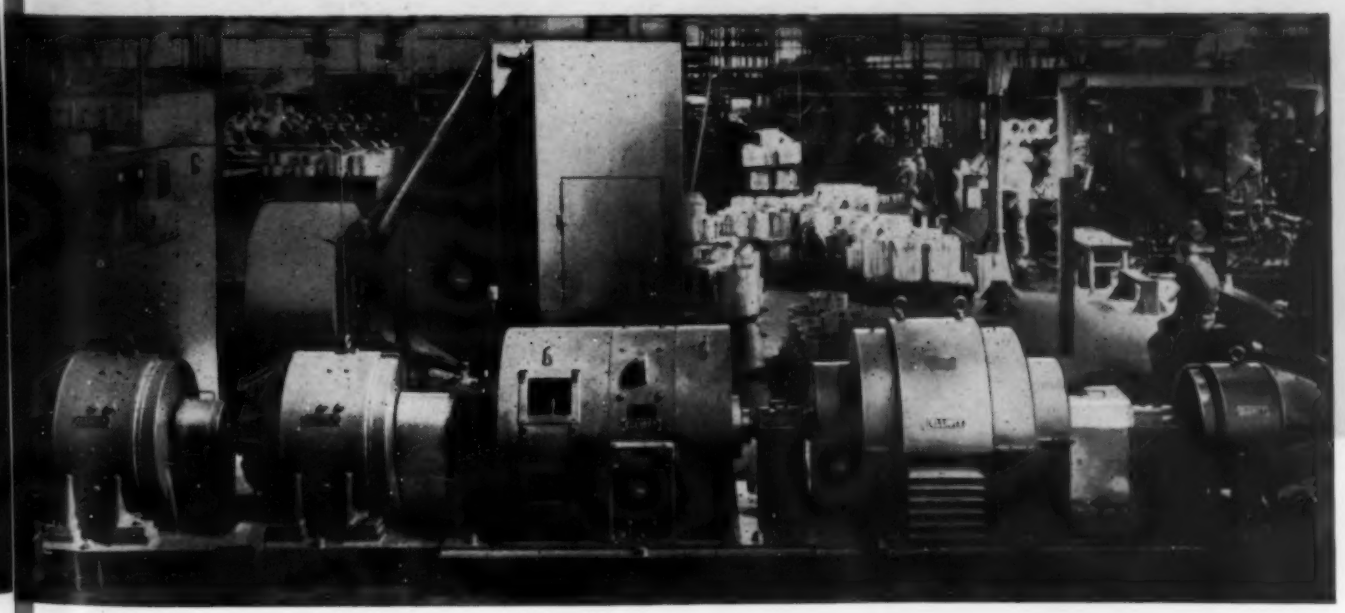
● In these important installations, Elliott supplied not only the adjustable-voltage main drive motors for the four new mills, but also motors for constant-voltage auxiliary drives such as lube drive, screwdown, reel traverse, air-wipe blower, buggyhoist, and roll changer.

Control is Cutler-Hammer, developed in close cooperation with Elliott engineers.

An article giving details of these installations, involving mills designed for rolling brass and copper strips in coils weighing up to 5000 lb. at a mill speed of 500-1000 ft. per min. was published in the Winter issue of our quarterly magazine, POWERFAX. Copies can be obtained from your nearest Elliott Company district office or write direct to Advertising Department, Elliott Company, Jeannette, Pa.

ELLIOTT Company

RIDGWAY DIVISION • CROCKER-WHEELER DIVISION



R3-4

FOR HOTTER FUELS BIGGER LOADS—

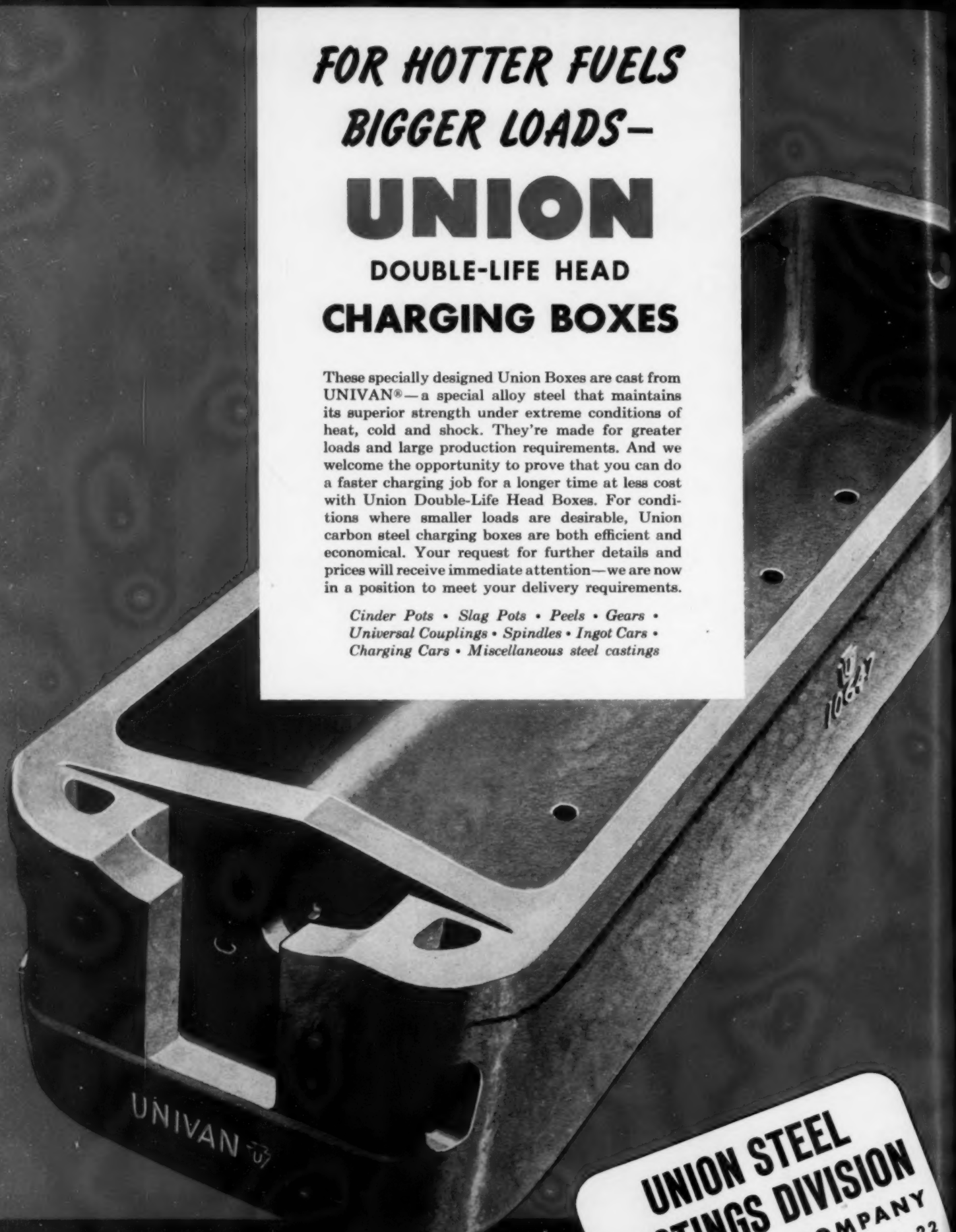
UNION

DOUBLE-LIFE HEAD

CHARGING BOXES

These specially designed Union Boxes are cast from UNIVAN®—a special alloy steel that maintains its superior strength under extreme conditions of heat, cold and shock. They're made for greater loads and large production requirements. And we welcome the opportunity to prove that you can do a faster charging job for a longer time at less cost with Union Double-Life Head Boxes. For conditions where smaller loads are desirable, Union carbon steel charging boxes are both efficient and economical. Your request for further details and prices will receive immediate attention—we are now in a position to meet your delivery requirements.

Cinder Pots • Slag Pots • Peels • Gears • Universal Couplings • Spindles • Ingot Cars • Charging Cars • Miscellaneous steel castings



BLAW-KNOX

UNION STEEL CASTINGS DIVISION
BLAW-KNOX COMPANY
PITTSBURGH 22
PENNSYLVANIA
BLAW-KNOX

A Case in Point...

The modern rolling mill is a succession of related mechanical operations. The over-all efficiency of the mill is determined by the efficiency of each mechanical unit . . . and how well it is related to previous and subsequent operations.

The record tonnages being achieved on Morgan mills and the continued world-wide demand for them is proof of their success. Nevertheless our engineers continue to develop and put into operation new ideas and improvements. A case in point is the Rotary Disc Shears described below.

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Rep., International Construction Co., 56 Kingsway, London, W. C. 2, England

RM-68

ROTARY DISC SHEARS . . . These shears have the capacity to cut bars up to 1¾" diameter at speeds up to 3000 f.p.m. The opening and closing of the knives is performed hydraulically, dispensing with the use of magnetic clutches and brakes thereby eliminating all "creep" and making the action positive and precise. The Vee-shape cutting edge of the knives leaves no "beard" or slivers where the cut is made. Here we show twin shears for double strand rolling.

MORGAN
WORCESTER
ROLLING MILLS - MORGOIL BEARINGS
WIRE MILLS - GAS PRODUCERS - AIR EJECTORS
REGENERATIVE FURNACE CONTROL

"Savings: $50,000.00 A YEAR... ...WITH OUR *Trabon* AUTOMATIC LUBRICATION SYSTEM"

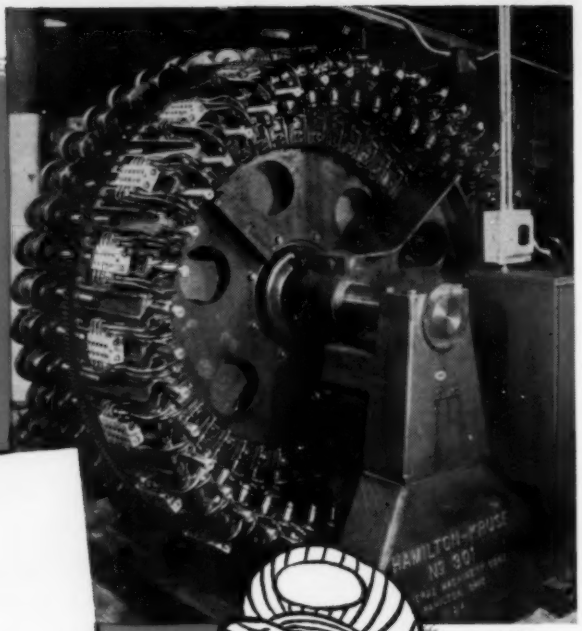


Photo Courtesy Cans, Inc.

CANS, INCORPORATED

3217 WEST FORTY-SEVENTH PLACE • PHONE FRONTIER 6-2700

CHICAGO 32, ILL.

August 5, 1952

Dudley C. Jackson, Inc.,
6752 Stony Island Avenue
Chicago 49, Illinois

Subject - Trabon Automatic Lubrication Systems

Gentlemen:

Through the installation of the Trabon automatic lubrication system on our air testers on the dog food can assembly line, we cut down on lubricating costs 95% and also reduced our production downtime for lubricating purposes from three hours per day to approximately 15 minutes per day. This machine has 249 grease fittings which formerly required attention after every 8 hour shift. The lubrication by hand required the services of one man for one hour after each shift on an overtime basis.

In addition, other desirable savings have been realized through the assurance of proper lubrication. It has brought about an 86% savings in grease consumption. Excess grease formerly accumulated on machine parts and eventually worked its way on to the cans, resulting in a high rate of rejected cans which had to be wiped clean by hand. The previous inefficient hand method of lubricating resulted in the neglect of some vital parts causing approximately 100 hours of downtime per year and approximately $1200.00 labor and material cost to replace the parts. In terms of production, this amounts to over 2,000,000 cans or a loss in sales of well over $50,000.00 annually. At present, repairs are scheduled and no production time is lost. It is estimated that our lubricating costs alone are reduced to $100.00 per year, a reduction of over 90% which is enough to pay for the entire cost of the Trabon automatic lubricating system. The biggest savings, of course, is in the elimination of downtime which, as every manufacturer knows, is a very costly factor.

This automatic lubricating system has fulfilled its purpose beyond all of our expectations.

Very truly yours,

CANS, INCORPORATED

R. S. Solinsky

R. S. Solinsky
President

A. M. Toft

A. M. Toft
Vice President

RSS:tf

Specialists in the Manufacture of Plain and Decorated Metal Containers and Housewares Items.

CANS

this has a BEARING on the subject

For more than 22 years, Trabon has been saving thousands of dollars for a wide variety of metal-working and metal producing plants, by its patented centralized lubrication systems for either oil or grease.

Get your bearings on a Trabon System. Bulletin 529 will be sent promptly on request.

Trabon Lubrication Fits Any Bearing Situation

Trabon ENGINEERING CORPORATION

1814 E. 40th STREET • CLEVELAND 3, OHIO

Oil and Grease Systems

Equipment News...

BORING-MILLING MACHINE

▲ Castings weighing nearly a million pounds and forgings hammered out of ingots weighing over a half-million pounds will be accurately machined and neatly assembled by the Mesta Machine Co. to give the United States one of the world's largest hydraulic presses. The press will have a capacity of fifty-thousand tons and will be capable of squeezing slabs of aluminum and magnesium alloys into airplane sections.

To precisely machine the mammoth sections of this gigantic forging press, it was necessary for Mesta to design and build a huge horizontal boring and milling machine. This multipurpose machine tool is capable of boring, drilling, tapping, and milling operations.

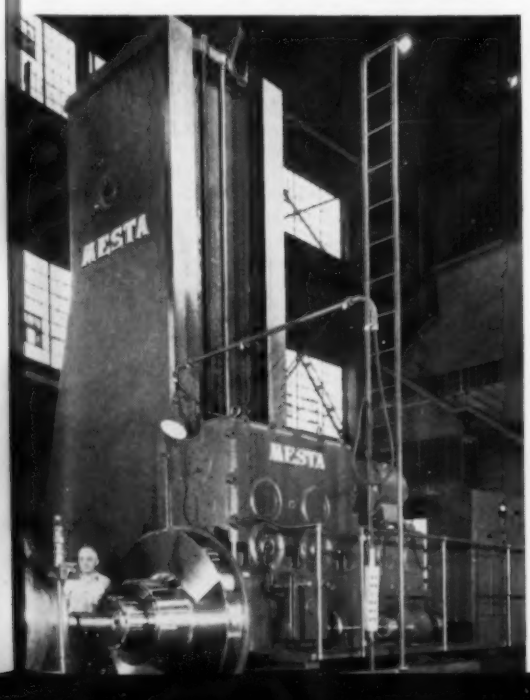
This machine can drill and bore holes from 3 in. in diameter to over 10 ft in diameter. The 18 in. diameter spindle has a variable speed of .75 rpm to 56 rpm and has a maximum stroke of 8 ft.

The machine is made of heavy cast construction throughout, and was designed for the most rugged service. It has an over-all height of 24 ft 3½ in.

The machine proper consists of a main base with a moving column and saddle. The iron castings were made of close grained air furnace iron and the steel castings were made of high quality acid open hearth steel. The column was cast in one piece and mounted on ways of the heavy cast iron base. It is arranged with horizontal rapid traverse and feed through a special bronze nut and a forged steel screw along the bed, for a distance of 30 ft. The weight of the column and saddle on the ways is relieved by springs.

The cast iron saddle mounted on the side of the column has a vertical travel up to 13 ft. The vertical traverse and feed is obtained through a vertical screw. Complete gearing is enclosed in the saddle case for all traverse feed and tool motions. Sliding gears are controlled by hand levers, conveniently located for the operator on the outer case.

This giant horizontal boring and milling machine was built to machine sections of new heavy forging press.



MILLIONTH MOTOR

▲ The "one-millionth" motor since the opening of the plant in 1946 has come off the line at the Buffalo, N. Y., motor and control division of the Westinghouse Electric Corp.

Completion of the motor, a 7½-hp "Life-Line" model that is typical of those used to drive machine tools, culminated production of 10,009,292-hp of capacity in electric motors.

In an interview held while the "milestone" motor received the finishing touches, Tom Turner, vice president, said that more than 13,000 tons of copper, 110,000 tons of steel, and 1400 tons of aluminum have been used during the six years of production. Comparing the millionth motor to one more than 50 years old on display at the plant, Mr. Turner said that "although smaller and extremely lighter, the new motor has the same horsepower rating and is more efficient than the old model."

Although Mr. Million will be packed and shipped out in the normal manner, plans call for eventual return to the plant for display purposes. To implement this plan, the motor will bear a special identification nameplate, in addition to the regular one, and $100 will be awarded to the customer employe who discovers it.

In addition to the million electric motors Westinghouse has produced in Buffalo, the small motor division, Lima, Ohio, and the transportation and generator division, East Pittsburgh, Pa., have produced many millions more. These range in size from a midget motor having a rating of two millionths of one horsepower to the world's largest motor — a 225-ton, 83,000-hp giant shipped recently from East Pittsburgh. The tiny model is ⅝ in. long and is used to drive an electric meter; the giant is nearly 22 ft high and will help drive the fans in a supersonic wind tunnel in Tennessee. Other motors of various "in between" sizes drive refrigerators, washing machines, street cars, steel mill equipment, conveyor systems, machine tools, pumping stations and many other types of equipment in almost every phase of American life.

RECORDER-CONTROLLER

▲ A new combined temperature recorder and temperature-difference controller for fast, accurate reversal of regenerative furnaces is now being offered by Leeds & Northrup Co. The controller provides — in one instrument instead of the conventional two — continuous recording of checker temperature, simultaneous measuring of temperature difference between regenerators, and either automatic furnace reversal or warning for manual reversal when pre-set difference is reached. This marks the first time such a combined instrument, in which these furnace factors can be recorded, analyzed and regulated, has been offered to users of regenerative furnaces and glass tanks.

The controller draws a two-point continuous line record of the temperatures of checkers at opposite ends of the furnace. It does not record temperature-difference as such, but plots a record of high and low temperatures, with the width of the recorded band between them showing temperature-difference. This distinctive record is easily read at a distance of several feet.

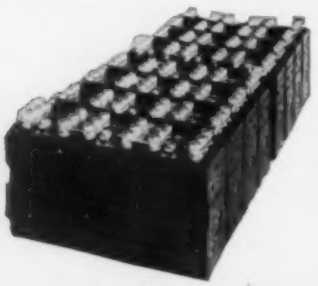
The L&N combined temperature recorder and temperature-difference controller is available for use with

NICAD

MADE IN U.S.A.

T-TYPE BATTERY
for
RAILROAD
DIESEL STARTING

2 models—THR-30, THR-44



SAVES UP TO 100 MAN HOURS PER YEAR PER LOCOMOTIVE

Because the NICAD nickel cadmium storage battery requires less maintenance you save precious man hours and, at the same time, are assured of reliable, foolproof battery service throughout its long life. The T-Type NICAD battery has an exceptionally high ampere rate of discharge at useful voltage, a vital consideration in engine-starting applications.

BATTERY TYPE	AMPERE HOURS	NUMBER OF CELLS	GROUP TRAY LENGTH A	TRAY WIDTH B	WEIGHT LBS.
THR 30	142	48	33¾"	8"	1835
THR 44	210	48	44¾"	11"	2675

THR-30—Interchangeable with 17-plate, 248 A.H. Lead Acid Batteries
THR-44—Interchangeable with 25-plate, 426 A.H. Lead Acid Batteries

NICAD IS LIGHTER, NEEDS NO ADDITIONAL SPACE

Exceptionally Long Life — *Low Internal Resistance*
Low Cost Operation — *Rugged Steel Construction*
Negligible Water Consumption — *Very Low Self-Discharge*
Uses Standard Charging Equipment

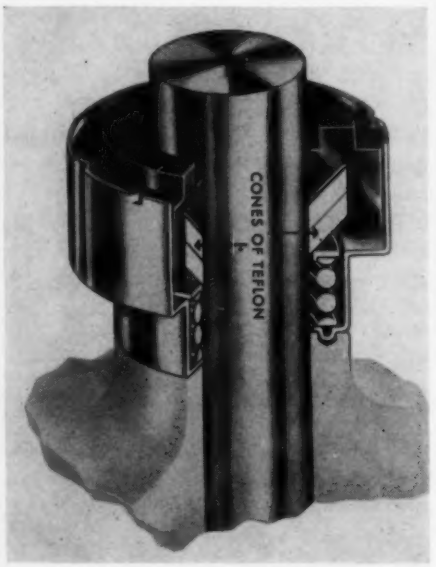
Other NICAD Applications in:
UTILITIES HEAVY AUTOMOTIVE
MARINE RAPID TRANSIT
LABORATORIES

NICAD
NICKEL CADMIUM BATTERY CORPORATION
100 Park Ave., New York 17, N. Y.
Factory—Easthampton, Mass.
Chicago Office—30 N. La Salle St.
MADE EXCLUSIVELY IN THE U.S.A.

either thermocouples or "Rayotube" detectors. It can be used in a complete L&N "packaged" reversal control system, or tied-in with other reversal equipment.

ALL-PURPOSE SEAL

▲ A new all-purpose mechanical seal, completely proven in design and construction, has been announced by the Crane Packing Co. Known as the "John Crane Type 19," the seal is said to provide life-time performance in small pumps, hot water circulators, and many other rotary shaft applications.



Special beveled cones made of teflon are utilized as the flexible member. This adapts the seal for services involving water, oil, corrosives or acids; temperatures from —100 to +450 F; vacuums and pressures to 200 psi; and high shaft speeds.

Being a packaged type unit, the seal provides quick and easy installation for production assembly and replacement service. It is presently available in sizes to fit shaft diameters of ¼, ⅜, ½, ⅝ and ¾ in. The metallurgy of the seal, bronze, stainless steel, etc., can be specified to meet service requirements or operating conditions.

WHEEL LUBRICATOR

▲ Lubrication of conveyor trolley wheels, long either neglected or done by hand with resultant conveyor stoppage, waste of manpower and lubricant, and risk of injury to workmen performing the job, has been made automatic, certain and safe by a new and unique lubricator just announced by the Alemite division of Stewart-Warner Corp.

The new lubricator delivers a preset, constant shot of either oil or lubricant to each trolley wheel on each side of the conveyor system into which it is installed, simply by the flick of a switch. When every wheel in the system has been serviced, the system may be switched off and is in constant readiness to go into operation again at whatever lubrication interval load and other conditions require.

The entire unit is contained on a section of I-beam 37¾ or 40 in. in length which is fitted into the conveyor track at any convenient spot in its length, so long as the location is within reach of the house air line and a 115-volts, 60-cycle electrical outlet. Head-room of 22 in. over the top of the I-beam is required.

As each wheel reaches the spot on the track at which the lubricator is installed, a coupler clamps the lubricant fitting on its hub and delivers the required amount of lubricant or oil. The coupler instantly disengages and is ready for the next wheel.

As the applicator and coupler engage the grease fitting on each wheel, a pressure of from 800 to 1000 lb is applied which forces the lubricant into the bearing. The amount of lubricant can be adjusted to .005 cu in. — enough for 32,000 shots from

(*Please turn to page 222*)

SPECIAL DELIVERY

Because power was needed in a hurry for a vital aircraft plant expansion program at Tucson, Ariz., three 6400-lb Pennsylvania "Pole Star" transformers were rushed to the site recently in a giant C-124 "flying box car." The completely assembled, oil-filled transformers were loaded onto the Air Force plane at Greater Pittsburgh, Pa., Airport late February 14, then began their non-stop westward flight early the following day. All three of the transformers shipped were 500 kva, 46 kv. They are to be used in the pre-flight testing section of an aircraft plant now being expanded for modification of one of the Air Force's largest jet bombers.

TREADWELL

CINDER CARS

AIR - STEAM OR ELECTRIC MOTOR DUMP

800 CUBIC FOOT TWIN POT CAR

Increased Blast Furnace Capacity

REQUIRES

Additional Cinder Handling Equipment

TWIN POT CARS will enable you to HANDLE 20% MORE SLAG on the same track length

M. H. TREADWELL CO., INC.

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140 CEDAR STREET
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WOrth 4-5344

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ATlantic 1-8800

HEAD, WRIGHTSON AND CO., LTD., Thornaby on Tees England

Research... cornerstone of advanced instrumentation

RESEARCH is a job that never ends. This holds particularly true in the field of instrumentation, for every advance in manufacturing procedures brings a demand for better techniques for measurement and control.

But research, to fulfill its true function, must do more than keep pace with progress. In Honeywell's Industrial Division, research points far beyond today's frontiers. Here, skilled scientists are intensively engaged in programs that are developing solutions not only for present problems, but also for the much more demanding applications of the future. Drawing on the related sciences of physics, electronics, metallurgy, chemistry and nucleonics, they are helping to bring instrumentation into its own as a new and essential science. Fundamental research, which attacks control problems in their most basic aspects, is supplemented by development studies to evolve practical equipment for factory use. Working in close cooperation with research, Honeywell application engineers translate new developments into working systems, custom-fitted to today's process requirements.

Covers all phases of control

Each of Honeywell's several laboratories works in specialized but related phases of instrumentation.

The primary elements laboratory, for example, searches into ways to improve the performance of today's elements—and to utilize the latest scientific discoveries in producing new detecting devices with greater range, speed, flexibility and accuracy.

In the precision measurement laboratory, Honeywell's own "Bureau of Standards" performs the most exacting electrical and mechanical measurements to provide precise evaluation of new developments.

The nuclear engineering laboratory develops specialized techniques of measurement and control essential to the nation's accelerated atomic energy program.

The servomechanisms laboratory studies the techniques which will be needed to control the "automatic factory" of the future . . . operates processes in miniature, and analyzes their control performance.

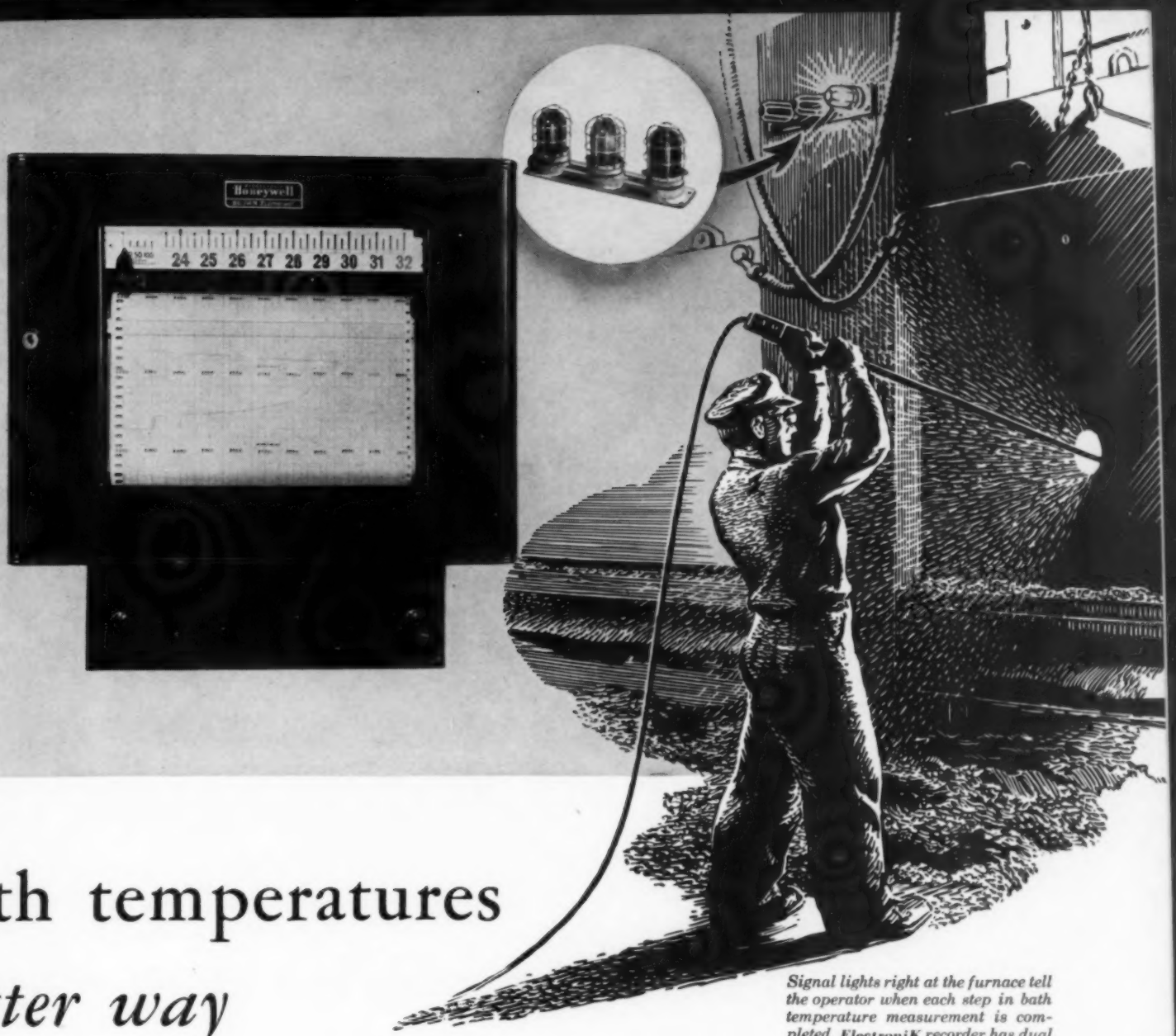
What of tomorrow?

To the instrument user—in factory or laboratory—Honeywell's research has twofold significance. It assures continued refinement of instrumentation for the measurement and control work that's to be done today. And it promises new and revolutionary equipment from Honeywell . . . "First in Controls" . . . for the increasingly important role that instrumentation will play in tomorrow's world.

Now— measure *this easier,*

PRECISION MEASUREMENTS *aid study of new pressure measuring elements.*

NEW CONTROL TECHNIQUES *are developed in the servomechanisms laboratory.*



bath temperatures *better way*

Signal lights right at the furnace tell the operator when each step in bath temperature measurement is completed. ElectroniK recorder has dual scale for ambient and bath temperatures...automatically switches range.

NEW AUTOMATIC signalling features incorporated in the *ElectroniK* recorder now bring greater simplicity and economy to the measurement of steel bath temperatures by the immersion thermocouple method. Integral signalling circuits in the recorder actuate remote color-coded lights near the furnace, to tell the operator when:

- . . . thermocouple is properly connected and in operating condition.
- . . . instrument is standardized and ready to record.
- . . . thermocouple is preheated to correct temperatures.
- . . . recorder pen has reached actual bath temperature.

The operator can make a complete measurement on signalled information alone . . . doesn't need to consult the *ElectroniK* recorder, which can be located remote from the furnace.

Thermocouples last longer, because the operator leaves the element in the molten bath only long enough to get an accurate reading, as indicated by his signal lights. This operating feature, in a typical installation, paid for the entire instrument cost in a single day's operation.

The *ElectroniK* signalling recorder is equally applicable to measurements in the furnace or in the spoon. Our local engineering representative will be glad to discuss how this instrument can improve the accuracy, speed, and economy of bath measurements in your shop. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA: Write for Instrumentation Data Sheet No. 6.7-8a.**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

(*Continued from page 218*)

the five pound grease or 2½-qt reservoir.

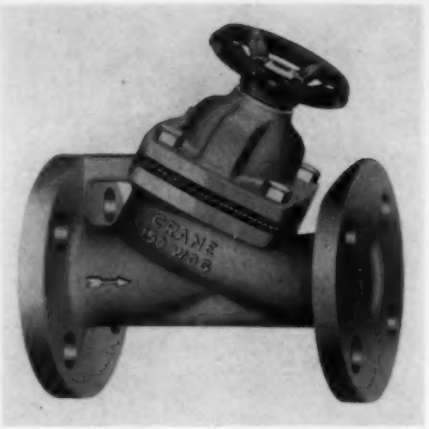
Wheel spacing is no problem — they can be yards apart, irregular in spacing or as close as 8 in. on centers, and it is as easily adaptable to wheels 3 in. in diameter as 4 or 6 in.

When grease is used, the house air is regulated to apply pressure to a follower plate on the lubricant to assure delivery of lubricant to piston plunger.

The new lubricator, sold as a "package unit" complete with a section of track, also includes the lubricant reservoir, right and left hand lubricator assemblies with protective covers and anchor plates. As an accessory to the trolley wheel lubricator, Alemite's Oil Mist system can be installed to automatically lubricate chain linkage and knuckle joints of load pendant hooks.

DIAPHRAGM VALVE

▲ Crane Co. has announced the addition of several new body, diaphragm, and lining materials to its line of packless diaphragm valves.



These valves are now regularly available with cast iron, brass, aluminum, or 18-8 Mo bodies and disc holders; and with diaphragms and disc inserts of Neoprene, Buna-N, and soft natural hard rubber linings. Specially prepared valves for vacuum, oxygen, and acetylene service are also now regularly available.

Outstanding feature of the Crane diaphragm valves is the separate diaphragm and disc construction. Since the diaphragm is not used for seating, it is not subjected to the cutting, crushing, and abrasion that lead to rapid wear. Closure of the independent disc will prevent escape of line fluids even if the diaphragm should fail.

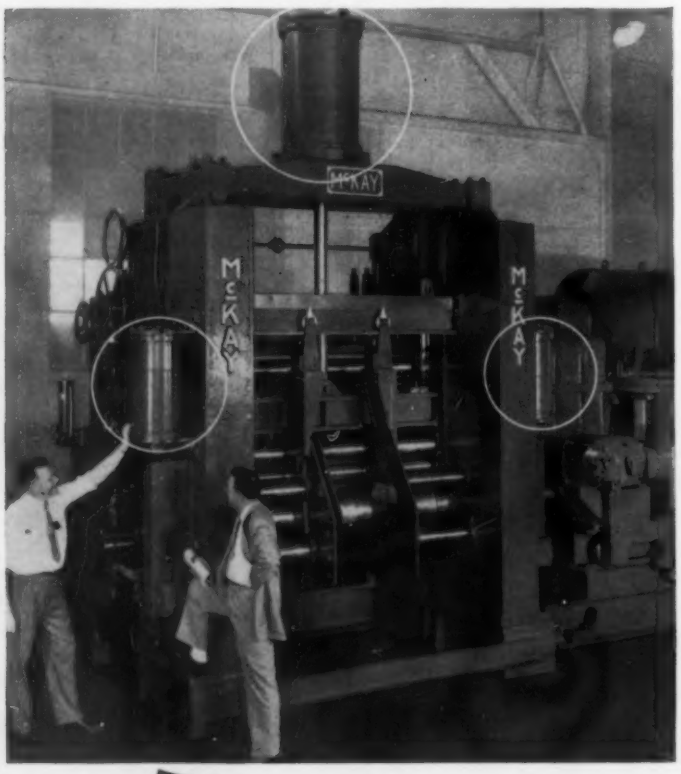
SAFETY PLATFORM

▲ Nichols Engineering Co. has developed a new safety tank car platform which eliminates the dangerous hazard of a man standing and working on the curved slippery top of railroad tank cars during loading and unloading operations.

The platform is supported on a steel column which is bolted upright to a concrete base along side the railroad tracks. From the grated deck of the platform the operator can turn the platform 360 degrees, stopping at any angle over the top of the tank car. Or he can service two tank cars one on each set of tracks on each side of the platform.

When the platform is in position over the top of the tank car the operator can open the top, insert the unloading pipe, couple it up without stepping on top of the tank car.

The platform is carefully balanced and rides on roller bearings so it is



INFORMATION *on the complete line of Anker-Holth products is given in this bulletin. Free on request.*

Help yourself to this

"CYLINDER KNOW-HOW"

ENGINEERS of the Steel Industry find it helpful to call in Anker-Holth engineers on power motion problems. Push, pull, lift or lowering action . . . air or hydraulic power . . . regardless of your problem, feel free to ask for the competent help of the nearby Anker-Holth man!

Specify Anker-Holth cylinders. There is a wide range to meet your specific needs, including heavy-duty types for steel mill equipment such as shown here. Write for bulletin. Anker-Holth Division of The Wellman Engineering Company, 2723 Conner St., Dept. E-1, Port Huron, Mich.

Anker-Holth

ENGINEERED CYLINDER POWER

WELLMAN

Division of

THE WELLMAN ENGINEERING COMPANY

Wellman will build it

Special Cranes
Ore Bridges
Gas Producer Plants
Charging Machines
Car Dumpers
Gas Flue Systems
Gas Reversing Valves
Coke Pushers
Mine Hoists
Skip Hoists
Clamshell Buckets
Forging Manipulators

Wellman ore bridges

New 577 foot span speeds handling of ore

Wellman 17 net ton ore bridge. Total length 577 feet.

● This new installation, built for one of America's largest steel companies, embodies many engineering features which speed the handling of ore and curtail costs.

Wellman's more than half-century of experience is at *your* service . . . to engineer and build equipment to improve your operations.

THE WELLMAN ENGINEERING COMPANY

7000 CENTRAL AVENUE • CLEVELAND 4, OHIO

easily turned by the hand crank wheel on the platform which is geared to the supporting steel column. In order to turn the platform the operator must hold down a foot brake which holds the platform stable in the stopped position. When not in use a bolt lock holds the platform in a safe position parallel to the tracks out of the way of passing cars.

The piping on the platform is supported by adjustable chains attached to overhead bracing; the liquid tight swivel joints, quick disconnect couplings and variable position of the platform make it possible to service cars not spotted right on the dot. The platform piping leads down through the supporting column, underground to storage tanks so there is no mess or waste of expensive liquids caused by stuck valves which often happens when unloading from the bottom of the tank cars.

New-type unloading platform permits the safe servicing of tank cars.

BRONZE WEAR STRIPS

▲ Ohio Knife Co., is offering wear strips in welded Ampco bronze. A special method of bi-metal welding is used, thus reducing the amount of bronze needed. Longer wear is achieved as wearing surface is aluminum bronze, proven far superior to ordinary cast phosphorous bronze. The bronze is welded to a soft steel base, readily machinable for required drilling, tapping and machining to required thickness. Surfaces are ground to close tolerance, thus reducing manufacturing and assembly time. A large assortment of sizes are available or made to special order.

MINIATURE TRANSMITTER

▲ A miniature pneumatic transmitter for measuring and transmitting readings of temperature, pressure, vacuum, differential pressure, and liquid level to recording, indicating, and controlling receivers, including miniature type receivers, has been announced by Bristol Co. Transmission is by means of air pressures of between 3 and 15 psi that have a direct relation to the measured quantity.

This new type of transmitter, known as the Bristol Series 650 pneumatic transmitter, uses standard

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

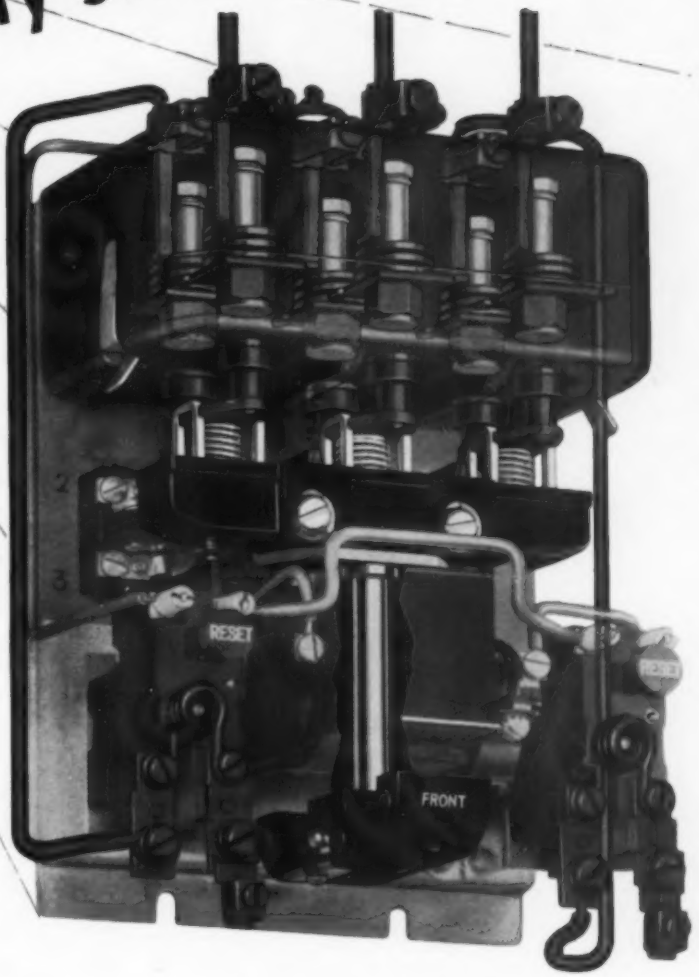
All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
245 MAIN ST., HARMONY, PA.

KEEP YOUR EYE

On this Heavy Duty Starter



Phantom view showing complete power circuit

The new CLARK Size 3, Type "CY" Starter, is built for heavy duty operation.

Pioneered and proved in the Size 2, Type "CY", the same principle is now offered to the Size 3.

The design embodies an entirely new concept.

For the first time in electrical control history, strong multi-turn magnetic blow-outs are combined with twin-break controls, in economical space.

Enclosing each arc chamber is a steel case which carries the flux, and is tops in non-carbonizing.

By applying the effect of the blow-out coil concentric with the contact, the arc is quenched.

The most important action is the constant forced rotation of the arc.

This forced rotation prevents the arc from striking repeatedly on the same spot.

This results in minimum contact wear and longer contact life.

Accumulation of ionized gases between the wiring terminals is prevented because the top of the arc chamber is closed.

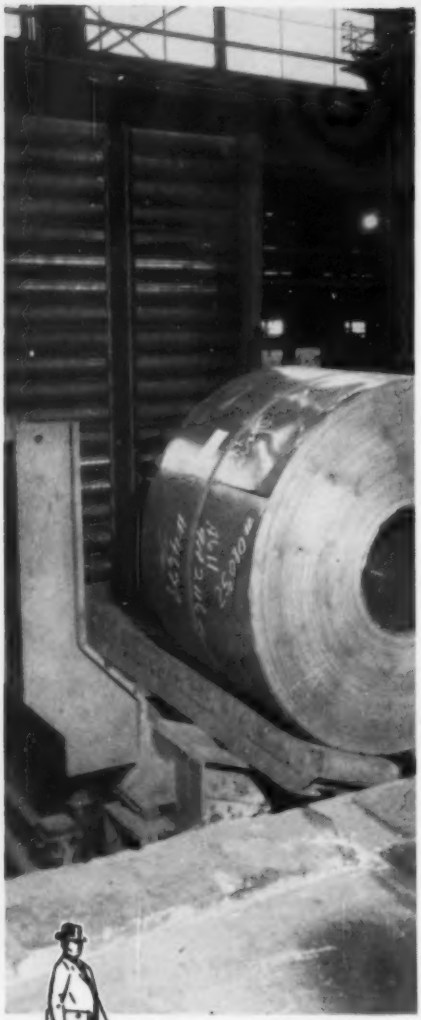
Thousands of CLARK Type "CY" STARTERS are giving satisfactory operation in all types of industry.

By using CLARK Type "CY" STARTERS your control problems can be simplified.

***You'd Better Try* CLARK *type* "CY"!**

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO.



THE MATHEWS ENGINEER BRINGS YOU 47 YEARS OF EXPERIENCE IN MECHANIZED HANDLING

Modern conveyer system work is a highly-specialized field . . . one in which there is no substitute for experience.

When you consult the Mathews engineer you get the benefit of experience, plus engineering resources and production facilities of three modern plants.

To get a greater return on your conveyer investment, better design, more efficient performance, longer service, call your nearest Mathews representative. Write for complete information.

MATHEWS CONVEYER COMPANY

GENERAL OFFICES
Mathews Conveyer Company . Ellwood City, Penna.
PACIFIC COAST DIVISION
Mathews Conveyer Company West Coast San Carlos, California
CANADIAN DIVISION
Mathews Conveyer Company, Ltd., Port Hope, Ont.

Bristol measuring elements and a simple transmitting mechanism with only one pivot and no flexures. Friction and lost motion are thereby eliminated for all practical purposes. The transmitter is sensitive to extremely small changes in the measured value, as little as 0.03 per cent of range, including reversal. High-speed transmission and superior control result from the use of a pneumatic relay which has an output capacity of 3.0 scfm.

The transmitter, weighing 7½ lb, is weatherproof and can be installed in any location and will operate in any position.

AIR-OIL REGULATOR

▲ For years North American "Ratiotrols" have helped to set the standard in the oil burning industry for an inexpensive but accurate method of correctly proportioning oil and air flow for combustion. Now, for the first time, these "Ratiotrols" are offered with a special tight shutoff feature, eliminating the need for expensive solenoid valves for hot furnaces where on-off operation is required. This tight shutoff feature is optional at little extra cost, and must be specified on the order if desired.

These units regulate flow by maintaining proportional pressures in the oil and air lines, a system based on scientific principle and proved in practice. They have a build-in ratio giving an outlet oil pressure twelve times greater than the air pressure. Because control is based on pressures, several burners (in one control zone) may be serviced by a single unit, and additional burners turned on or off without affecting the flow rate per burner. Flow rates for both oil and air are controlled by a single valve in the air line.

The units are offered in two sizes, a No. 13-01 rated at 25 gal per hr, and a No. 13-0 for 90 gal per hr. Both require an oil inlet pressure of 25 to 30 psi.

HOPPER TRUCK

▲ A unique truck eliminates the usual excessive physical exertion in opening and closing bottom gates in hopper cars such as those that bring iron ore from Minnesota mines. Thus, with this special-purpose vehicle, the power

Power wrench on truck cranks the bottom gates of hopper cars, eliminating the need for manual operation.

that is normally channeled into raising and lowering palletized and skidded loads, is shunted into the elimination of the back-breaking job of door manipulation. This truck is typical of the many specially designed vehicles produced by Elwell-Parker Electric Co.

Formerly, at the vessel-loading docks in the Lake Superior district, it was necessary for several crews of two men each to use 4-ft-long wrenches weighing 55 lb to open and close the gates.

Now however, with the aid of this special truck, one man can do the job, effortlessly, safely, and economically in a fraction of the time formerly required. Here's how it works: the wrench on the truck is moved horizontally to engage the opening and closing mechanism on the rail car. The wrench is then powered to crank the gates open or closed.

PIPE LINE FILTER

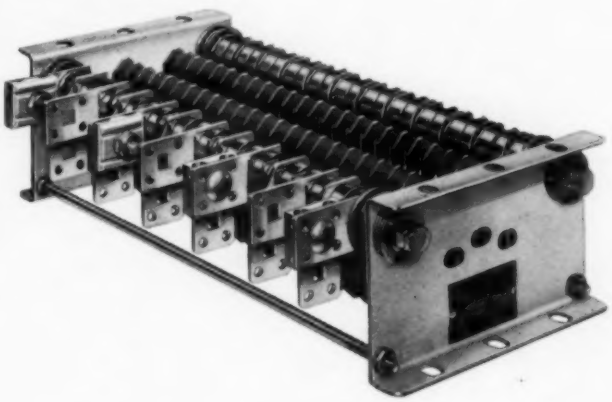
▲ Four new small pipe line filter models, designed for installations

(*Please turn to page 230*)

P-G *Steel Grid Resistors*

ARE BY COMPARISON SMALL UNITS... *but so important to production*

- **Steel Construction**
- **Mica Insulation**
- **Corrosion Resistant**
- **Vibration Proof**
- **Moisture Resistant**
- **Provision for Expansion**
- **Adequate Ventilation**
- **Rugged Terminals**



Resistors represent only a small part of a charging machine, but the duties they perform are of the utmost importance to its operation. In this stage of steel making, a charging machine must be able to start, stop, reverse and change speed regularly and continuously during its operating cycle. P-G Steel Grid Resistors have been handling their part of this job with a remarkable service record in many plants. For continuous "Trouble-Free Service" on this and all other steel mill applications, specify P-G.

Write for Bulletin No. 500

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

Right: Two 5000 hp main drive motors (at rear) are direct-connected through spindles to the top and bottom rolls. Exciter sets (foreground) provide adjustable a-c power to excite field windings of main drive generators and motors.

World's fastest reversing blooming mill powered by Westinghouse

Jones & Laughlin's new 46-inch, high lift blooming mill at Pittsburgh owns the world's record for fast reversal. In just one second, the 10,000 hp twin motor drive reverses from 40 rpm in one direction to 40 rpm in the other direction. Two giant motors turn smoothly at full base speed, and one second later—with no visible strain, no perceptible vibration —they're whirring with equal calmness in the opposite direction.

"Without a hitch". "This mill went into operation without a hitch," says George Kaufman, J & L's Chief Electrical Engineer. "Westinghouse Steel Mill Specialists worked with our engineers and the mill builder from the first. As a result, operation of the mill more than met the requirements of our engineering and operating departments."

At first, too fast. For fast reversals of the main roll motors to be of value, the auxiliaries (main roll screwdowns, mill table motors and manipulators) must also act rapidly. Proof that they do was shown in early tests. The manipulators, on the first try, operated so quickly that a ten-ton ingot was flipped completely over—180 degrees instead of 90.

Rototrols® speed operation. Rototrol regulators provide high forcing voltages to the mill auxiliary-generators and the main drive exciters. Due to the co-ordinated design of the regulating system, auxiliary-generator voltages are reversed in less than one second. Forced by fast voltage charges, the drive responds instantly to the operator's flip of the master switch.

Next time, call Westinghouse. Imaginative, dollar-saving engineering like this can be applied to *all* steel mill problems. When your next job comes up, take advantage of Westinghouse experience in steel—the widest in the electrical industry. Call your nearby Westinghouse office early in the planning stage. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-94987

YOU CAN BE SURE...IF IT'S

Westinghouse

HIGHEST OUTPUT OF
Quality Tubes

• Most manufacturers, when investing in an electric-weld tube mill, do so only after careful investigation, especially of performance records. Where, as often happens, records are available of the output and scrap losses of different mills, making comparisons possible, the choice of a Yoder is never in doubt. As a result, since their introduction in 1938, more Yoder mills have been installed in the U.S.A. and many foreign countries than electric-weld mills of all other makes combined.

In fact, the high quality and economy of tubing made in Yoder mills, have powerfully stimulated consumption and multiplied the uses for electric-weld tubing in the automotive, electric appliance, metal furniture and other mass production industries. The supply of such tubing, therefore, has never caught up with the demand.

Get the facts about Yoder mills, incorporating the latest developments in tube making, including the revolutionary new Yoder induction high speed welders for *non-ferrous as well as ferrous metals* and alloys.

THE YODER COMPANY
5495 Walworth Ave. • Cleveland 2, Ohio

Resistance Weld TUBE MILLS
ENGINEERING YODER MANUFACTURING

(*Continued from page 226*)

requiring only 40 psi maximum pressures for compressed air or gas, have been announced by the Dollinger Corp. The new filters feature one-bolt accessibility for quick inspection and cleaning without removing filters from the line.

The new small pipe line filters are available in any one or a combination of four models. They are manufactured in two sizes and each size can use either absorption pad media or the original Dollinger radial fin inserts. Larger size filter has a diameter of 3½ in. and a length of 6½ in. Larger size is 3½ in. in diameter with a length of 10 in. and offers more filtration surface. The AA Series of filters with absorption pad media remove last traces of oil and water vapor from lines. The CH Series with radial fin inserts are designed to rid lines of dirt and pipe scale.

BOILER TREATMENT

▲ Strong, Carlisle and Hammond Co. has announced its appointment as national distributor for the new "Borgana" boiler water treatment.

Several unusual claims are made for this product which is a liquid extracted from red cedar wood by a complex process. It was developed over the last ten years by the chemical division of Portland Shingle Co. of Portland, Ore., in cooperation with leading scientists.

By simply adding approximately one quart of the treatment per 100 hp per week, complete boiler treatment is obtained. The existing scale is softened and gradually removed, and further scale formation prevented. It is claimed that the new treatment will absorb oxygen and other corrosive gases commonly found in boilers, thereby eliminating corrosion and pitting. It also reduces or eliminates foaming and embrittlement.

Features claimed for the product are the elimination of complicated boiler water tests, simplicity of use, "pre-proved" effectiveness, no danger from over-treating, reduction of corrosion and the elimination of scale in boilers, traps and valves. The treatment is non-poisonous so that the steam from treated boilers may be safely used in direct contact with food.

In addition to its use in boilers, it also successfully treats cooling water in refrigeration and air conditioning systems, and other units where scale and corrosion difficulties occur.

PLASTIC COATING

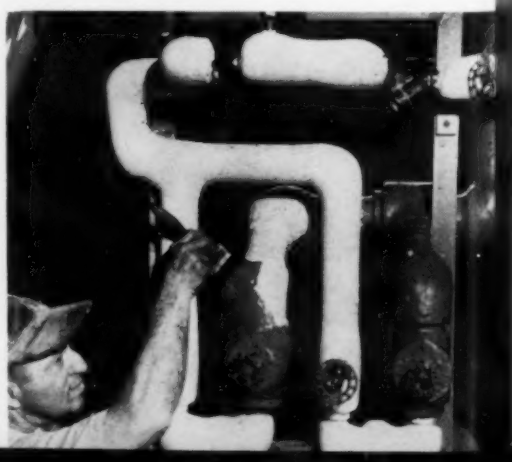
▲ A new plastic coating for use as both protection and color identification on insulated refrigerant, cold water, steam and other lines and insulated equipment has been developed by the Armstrong Cork Co.

The new finish, called "Insulcolor," is a tough plastic coating that can be either brushed or sprayed on.

The new finish will withstand temperatures to 160 F without cracking, shrinking, or crazing. It may be used over heat insulations, cork pipe covering and lagging, and also as a finish over cork-insulated air conditioning ducts.

The finish is available in white and six colors — light and dark green, light and dark blue, yellow and buff. For jobs where color is not desired or required for line identification, white provides an attractive, sanitary surface. The finish can be applied over standard asphaltic finishes without danger of bleed-through.

The tough finish furnishes high resistance to bumping and abrasion. It has high water resisting properties which make it suitable for either inside or outside applications. No inflammable solvents are used so that it's safe to use on the job. When dry, it is classified as fire-retardant. It is also entirely odorless.



"I could see the corpsman kneeling over me. The blood plasma was running down through a tube into my arm and he said everything was going to be O.K. I was walking across an enemy mine field in Seoul when one exploded and a piece of shrapnel caught me in the leg.

" 'Got enough of that stuff?' I asked him, pointing to the blood. 'I guess we never have enough,' he said, 'but you can thank *somebody* for this pint.'

"How do you thank 'somebody' for blood? For saving your life? When I got back home, I discovered the answer at my local blood donor center. There's only *one* way to say thanks—by giving some of your own blood."

"How do you thank 'somebody' for Blood?"

Yes, all kinds of people give blood—for all kinds of reasons. But whatever *your* reason for giving blood, this you can be sure of: Whether your blood goes to a combat area, a local hospital, or for Civil Defense needs—this priceless, painless gift will some day save an American life!

Business Executives!

✓Check These Questions!

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ☐ Have you given your employees time off to make blood donations?
- ☐ Do you have a Blood Donor Honor Roll in your company?
- ☐ Have you set up a list of volunteers so that efficient plans can be made for scheduling donors?
- ☐ Have you arranged to have a Bloodmobile make regular visits?
- ☐ Has your management endorsed the local Blood Donor Program?
- ☐ Have you informed employees of your company's plan of co-operation?
- ☐ Was this information given through Plant Bulletin or House Magazine?
- ☐ Has your company given any recognition to donors?
- ☐ Have you conducted a Donor Pledge Campaign in your company?

Remember, as long as a *single* pint of blood may mean the difference between life and death for *any* American . . . the need for blood is *urgent!*

Give Blood Now—Call Your Red Cross Today!

National Blood Program

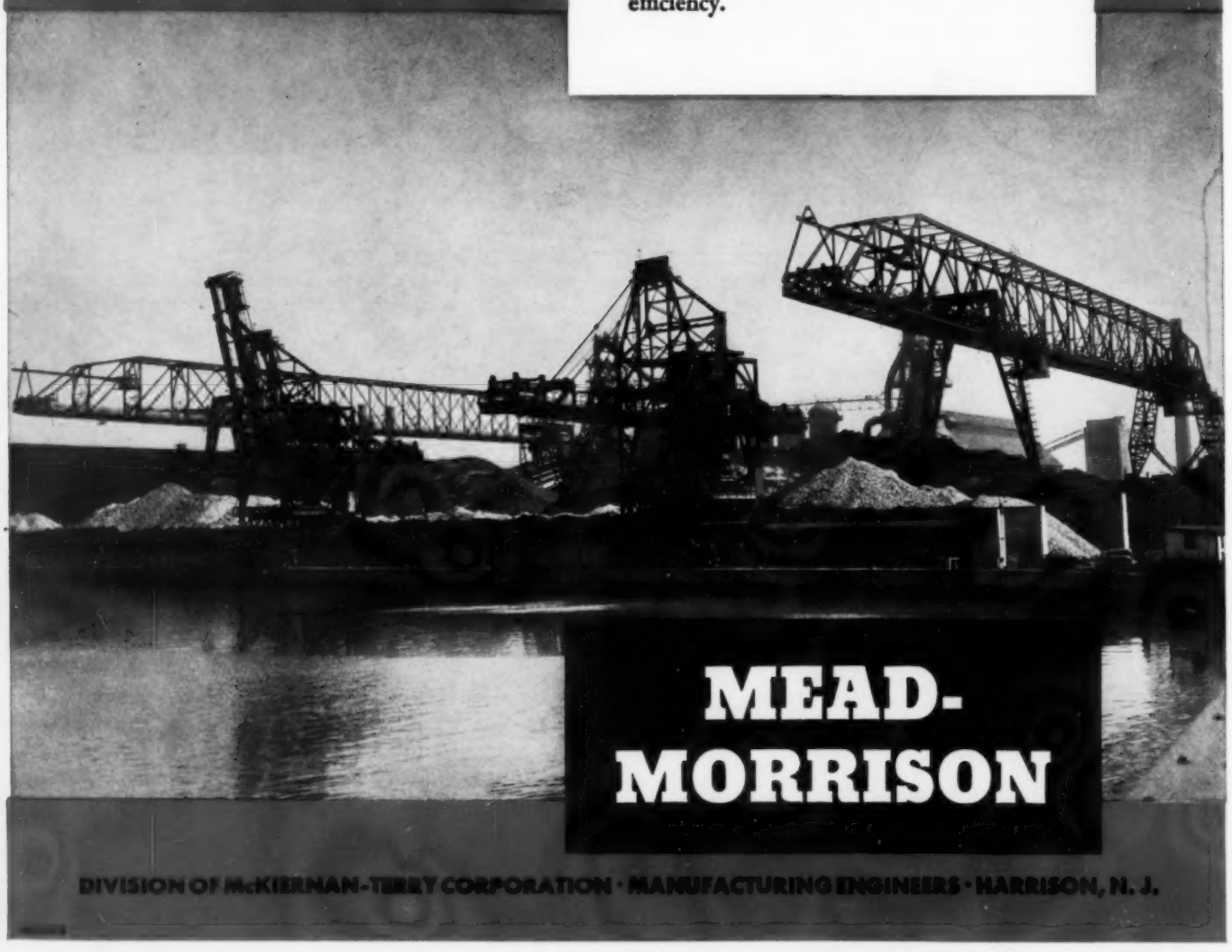
all set for speedy material handling

This team of two Unloaders and two Bridges are part of the Mead-Morrison material-handling equipment at a large midwestern steel mill.

Each of the structures and their equipment has a capacity of 12 tons and is of the man-trolley type. The unloaders discharge ore or limestone from lake steamers, and deposit it in the trough, from which it is rehandled by the bridges to storage piles and to the high line feeding the blast furnaces.

Additional Mead-Morrison Bridges and Unloaders are also operating in the coal storage yard of this same steel company.

If you need new unloading facilities or increased capacity from your present equipment, the Mead-Morrison engineers will help you plan for greatest efficiency.



MEAD-MORRISON

DIVISION OF McKIERNAN-TERRY CORPORATION · MANUFACTURING ENGINEERS · HARRISON, N. J.

the standard of the INDUSTRY

for more than 55 years!

BOWSER ESTABLISHED 1885

lubrication and liquid control systems have proved their dependability for more than 55 years in many rolling mills and other industrial plants. Bowser installations range from single units for individual stands to complete lubrication, filtration, oil storage and metering systems that serve entire mills.

Our Engineers Are Always At Your Service

BOWSER

BOWSER, INC., 1370 CREIGHTON AVENUE, FORT WAYNE 2, INDIANA

Regional Offices • Atlanta • Chicago • Cleveland • Dallas • Kansas City • New York
San Francisco • Washington, D. C. • Canadian Plant and Sales, Hamilton, Ontario

---

ONE MAN HANDLES IT EASILY

FARNCO
ALL ALUMINUM
CONVEYOR

Built to reach inaccessible places, carries brick, sand, flu dust, wet concrete. Can be used in multiple units for long hauls.

POWERED BY AIR GAS or ELECTRIC

Built of **STRONGEST, TOUGHEST,** aluminum
Designed and manufactured by precision engineers who specialize in close tolerances. **SAVES MANPOWER SAVES $ $**

NATIONAL DISTRIBUTORS
FARNCO SALES CO.
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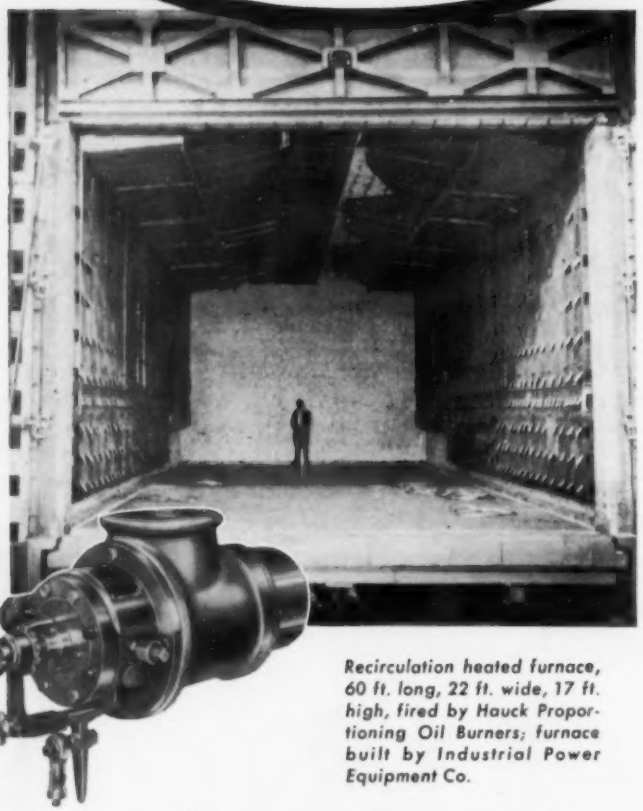
Get our illustrated literature, HOW it operates. →

Firing a BIG fellow



Recirculation heated furnace, 60 ft. long, 22 ft. wide, 17 ft. high, fired by Hauck Proportioning Oil Burners; furnace built by Industrial Power Equipment Co.

This large furnace is used for stress relieving massive weldments for hydraulic presses and turbines. It requires precise control of combustion conditions, temperature, rate of heating, length of soaking time and rate of cooling.

At the heart of this completely program controlled, recirculation heated furnace are twelve Hauck Proportioning Oil Burners which fire in groups of four into three large air heaters mounted above the furnace. They're mighty important in providing the kind of heating this operation requires.

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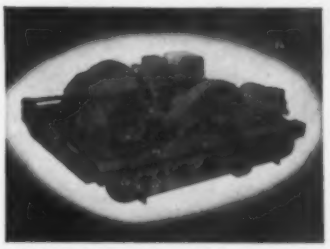

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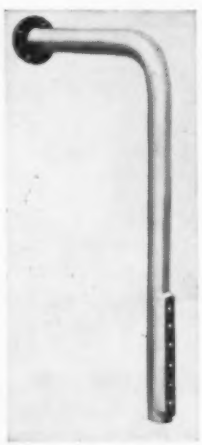

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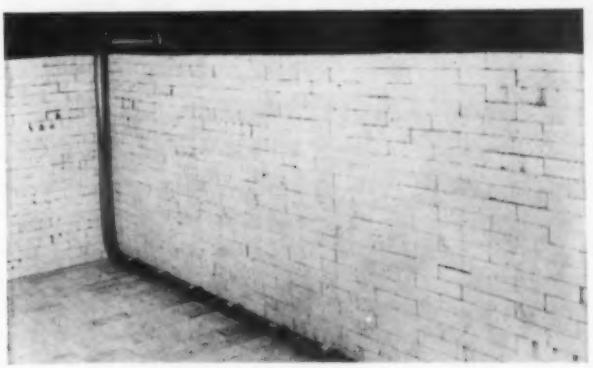

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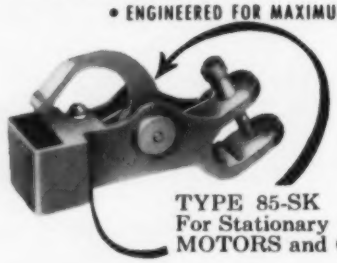

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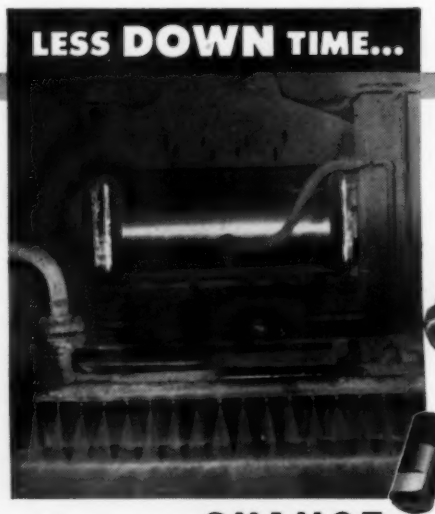

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Book Reviews . . .

▲ The 1952 compilation of "ASTM Standards on Petroleum Products and Lubricants (With Related Information)" brings together in compact, readily usable form, most of the ASTM standards, test methods, and specifications widely used in this field. Prepared by ASTM Committee D-2 on Petroleum Products and Lubricants, this edition gives in their latest form 135 ASTM standards. Copies of this widely used 831-page book can be obtained from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. at $5.75 each, heavy paper cover; $6.40, cloth cover.

▲ The Heat Exchange Institute has just released a new edition of its 20-page book, "**Standards for Steam Surface Condensers.**" It is a revision of the book on the same subject issued in 1939 and 1940, and it is one of a series of eight separate publications on different pieces of heat exchange apparatus. The object of the Standards is to help the purchaser of condensers by defining essential terms and by setting up definite standards of heat transfer rates and performance guarantees. It also contains material which is essential to engineers when writing specifications or designing surface condensing equipment. Copies of the book can be obtained at two dollars per copy (within the United States and Possessions) from: Heat Exchange Institute, 122 East 42nd St., New York 17, N. Y.

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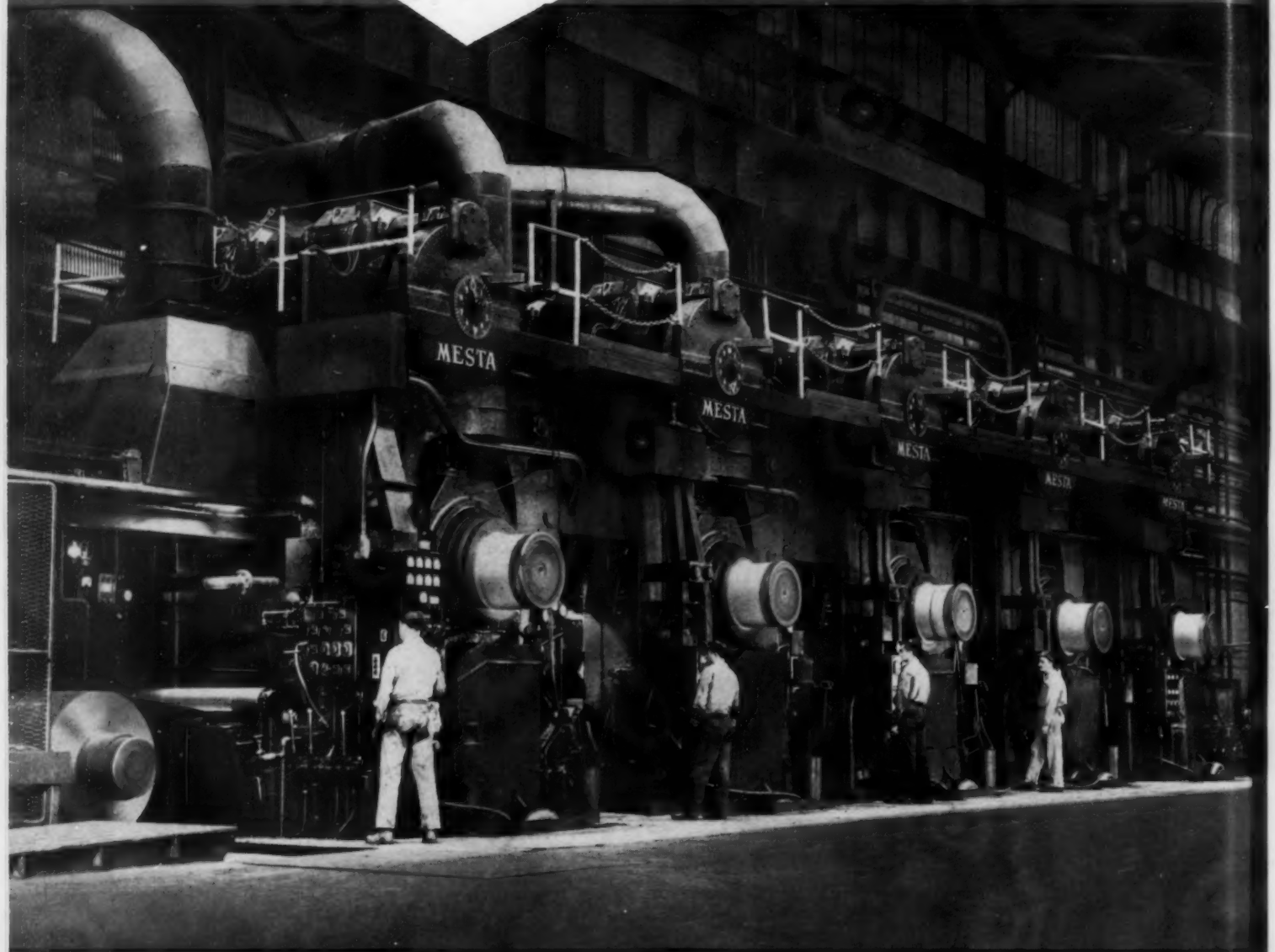

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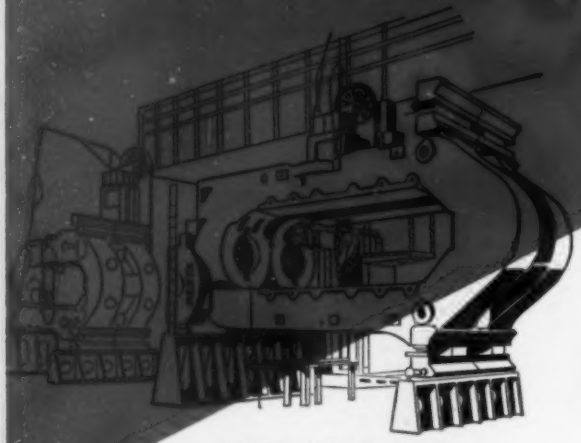

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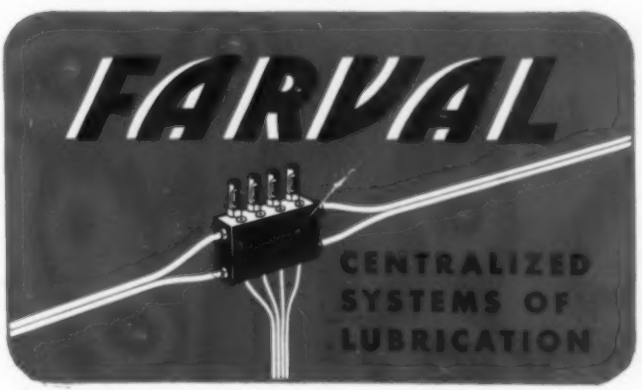

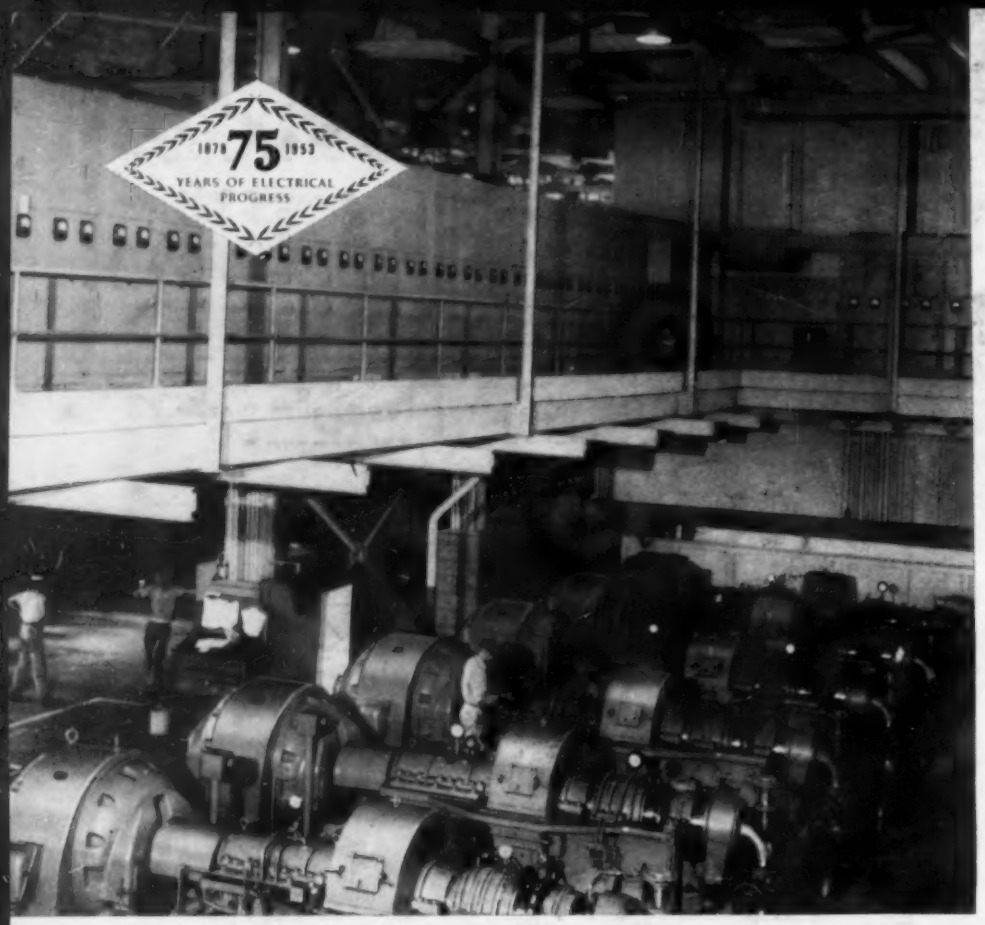

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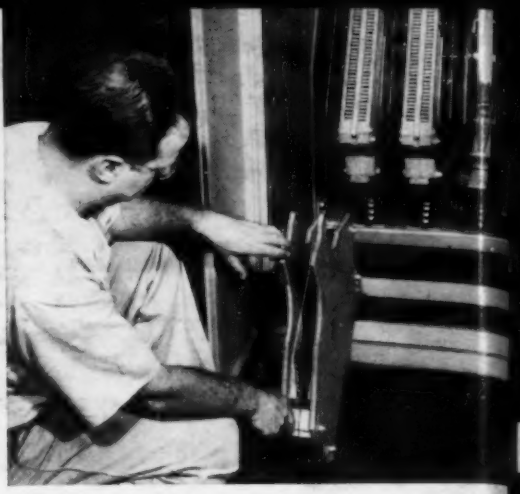
G-E Limitamp controls are delivered totally assembled, ready for service and need only be put in place, the leads connected, fuses inserted . . . the control is ready to operate.

For complete information contact your G-E Representative, or write for Bulletin GEA-5409A, General Electric Co., Sec. 781-3, Schenectady 5, N. Y.



MAINTENANCE IS EASY—for example: arc shute can be removed quickly, contact tips inspected, and your Limitamp control is right back in operation

SIMPLE TO OPERATE—G-E Limitamp control permits pushbutton operation for manual starting and stopping while meters provide a quick check on load

FUSES ARE EASILY REPLACED—when the fu swings forward on its hinge, it is easily lifted o and quickly replaced with the help of a switch hook

You can put your confidence in—

GENERAL ELECTRIC